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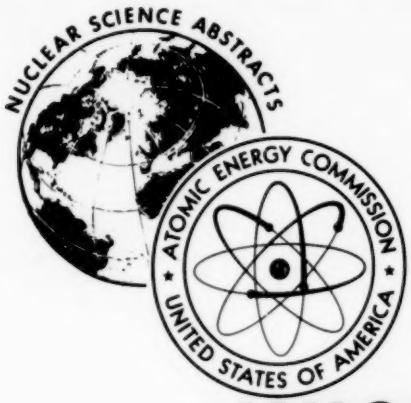

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

6910 (ANL-6906) BIOLOGICAL AND MEDICAL RESEARCH DIVISION SEMI-ANNUAL REPORT, JULY THROUGH DECEMBER 1963. (Argonne National Lab., Ill.). June 1964. Contract W-31-109-eng-38. 133p. Dep.; $4.00(cy), 3(mn) OTS.

Separate abstracts were prepared for 20 sections of this report. A list is included of 49 publications during the period covered by this report. (C.H.)

For abstracts of individual papers see: 6911, 6912, 6913, 6914, 6915, 6937, 6938, 6939, 6940, 6941, 6942, 6943, 6944, 6945, 7012, 7013, 7014, 7015, 7016, and 7176.

6911 (ANL-6906(p.27-40)) PROGRESS REPORT: DISEASES AND CARE OF LABORATORY ANIMALS. (Argonne National Lab., Ill.).

A system of monitoring the health status of all experimental animals is described. Data are included on the care and breeding of mice, rats, dogs, and Japanese quail (Coturnix coturnix). Methods are described that were used in monitoring colonies for the presence of disease producing organisms such as Salmonella, Pseudomonas aeruginosa, intestinal parasites, and Pasteurella pneumotropica. The efficiency of sanitizing operations in eliminating pathogenic microörganisms was evaluated and the maintenance of a colony of pathogen-free rats is discussed. The use of an ultrasonic unit for the removal of dental calculus from dogs' teeth is described. A study of the care and breeding of Japanese quail led to the conclusion that this species is satisfactory for use in laboratory studies. (C.H.)

6912 (ANL-6906(p.61-4)) DRY-EMULSION AUTORADIOGRAPHY. Lloyd J. Roth (Chicago. Univ.), Ake Hanngren (Sweden. Kunglia Veterinärhögskolan, Stockholm), and William P. Norris (Argonne National Lab., Ill.).

A technique is described for the preparation of autoradiograms by mechanically superimposing a nuclear emulsion upon an unwetted tissue section. The technique gave good resolution and reregistry at the cellular level when tested with rat ileum sections from an animal injected with ^{3}H-thymidine. (C.H.)

6913 (ANL-6906(p.65-9)) A RAPID BLOOD CATALASE SCREENING TECHNIQUE ADJUSTABLE TO ANY LEVEL OF ACTIVITY. Robert N. Feinstein, Judith B. Howard, Larry B. Ballonoff, and John E. Seaholm (Argonne National Lab., Ill.).

A screening test is described that was developed for use in the rapid screening of mice for blood catalase activity. The technique is based on perborate decomposition of catalase. (C.H.)

6914 (ANL-6906(p.117-25)) FINE STRUCTURE OF THE LACUNAE AND CANALICULI IN BONE. F. Wassermann and James A. Yaeger (Argonne National Lab., Ill.).

Observations made on the fine structure of bone using light and electron microscopic techniques and various histological staining methods are summarized. Methods used in the preparation of the specimens for microscopy are discussed. (C.H.)

6915 (ANL-6906(p.126-9)) VARIOUS ASPECTS OF FIXATIVES FOR ULTRATHIN SECTIONS AND RESOLUTION IN ELECTRON MICROSCOPY. Theodore N. Tahmisian, Carol J. Christiansen, Rosemarie L. Devine, and Betty Jean Wright (Argonne National Lab., Ill.).

Procedures are described for the fixation of ultrathin histological sections for examination by electron microscopy. (C.H.)

6916 EIGHTH INTERNATIONAL CANCER CONGRESS UNDER THE AUSPICES OF THE INTERNATIONAL UNION AGAINST CANCER, MOSCOW, 22nd to 28th JULY, 1962. Acta Unio Intern. Contra Cancrum, 20: 887-1243(1964). (CONF-620701)

One-hundred and seven (107) articles are included; separate abstracts were prepared for 27. Two articles on thymic tumor incidence and longevity of female mice irradiated with either fission neutrons or ^{60}Co gamma rays at different dose rates and modification of radiation response of tissue by colchicine were previously abstracted in NSA as 17: 10360 and 17: 24825. The remaining 78 articles include information on the biochemistry of cancer. (P.C.H.)

For abstracts of individual papers see: 6951, 7025, 7026, 7027, 7028, 7029, 7030, 7031, 7032, 7033, 7034, 7035, 7036, 7037, 7038, 7039, 7040, 7041, 7042, 7177, 7178, 7179, 7180, 7181, 7182, 7183, and 7222.

6917 THE AGGREGATION OF CHLOROPHYLL a. A. F. H. Anderson and Melvin Calvin (Univ. of California, Berkeley). Arch. Biochem. Biophys., 107: 251-9(Aug. 1964). (UCRL-10951)

Aggregation of chlorophyll a in various nonpolar solvents was demonstrated, and from the ir spectra the probable site of the hooking together of the molecules was deduced. If chlorophyll a exists in the cell in a completely nonpolar milieu (as the visible spectroscopic studies suggest), then CCl_4 solutions of chlorophyll a at high concentrations would be an ideal model for further biological studies, since it appears that this system most closely resembles that in nature. It would appear that only small traces, if any, of crystalline chlorophyll a exist in the cell. (auth)

6918 ON EQUATING LOW MOLECULAR WEIGHT RNA WITH TRANSFER RNA. D. L. Greenman, F. T. Kenney, and W. D. Wicks (Oak Ridge National Lab., Tenn.). Biochem. Biophys. Res. Commun., 17: 449-53(1964). (ORNL-P-135)

Data are presented that show that the assumption that any RNA with sedimentation characteristics like transfer RNA can be identified as transfer RNA to be erroneous. Studies were made on male rats that were given 3 mC of carrier-free ^{32}P intraperitoneally 50 min before they were killed. Results of both salt fractionation and migration on DEAE-cellulose sheets led to the conclusion that only about $\frac{1}{3}$ of the ^{32}P-cytoplasmic RNA was actually transfer RNA, although more than $\frac{2}{3}$ of this labeled RNA sediments with the

4 S peak on density gradient centrifugation. Therefore, it is clear that the appearance of an RNA in the transfer RNA region of a density gradient (or, by extension, of a methylated albumin column) cannot be taken as identifying that RNA as transfer RNA. (P.C.H.)

6919 SIGNIFICANCE OF THYMUS AND MARROW INJURY IN URETHAN LEUKEMOGENESIS. Nechama Haran-Ghera and Henry S. Kaplan (Stanford Univ., Palo Alto, Calif.). Cancer Res., 24: 1926-31(Dec. 1964).

Urethan at a dose level of 1 mg/gm body weight caused histologic damage and reduction of thymus weight in mice of strain C57BL. Thymic injury was only slightly less severe in 30- to 60-day-old mice than in 1- to 20-day-old mice. Urethan also produced bone marrow injury in mice of this strain, expressed as a loss of the capacity to promote thymic regeneration in irradiated test mice, which was age-dependent, occurring in donors 30 days of age or less, but not in donors $2\frac{1}{2}-3$ months old. Urethan-treated marrow from young donors was also significantly less effective than normal marrow in inhibiting lymphoma development in irradiated isologous hosts. It was concluded that the age-dependent capacity of urethan to act as a complete leukemogen is paralleled and presumably explained by the age-limited character of the marrow injury that it produces. Urethan leukemogenesis thus closely resembles radiation leukemogenesis in mice of strain C57BL with respect to the important role of concomitant injury to two tissues, the thymus and the bone marrow. (auth)

6920 OXIDATIVE PHOSPHORYLATION BY ROOT AND SHOOT MITOCHONDRIA FROM CORN SEEDLINGS AS AFFECTED BY TEMPERATURE. Leonard Beevers and J. B. Hanson (Univ. of Illinois, Urbana). Crop Sci., 4: 549-50 (1964). (COO-790-12)

Studies were made to determine if oxidative phosphorylation in plant mitochondria might not be differentially susceptible to high temperature. Mitochondria obtained from the roots and shoots of etiolated corn seedlings were used. Reactions were carried out at temperatures ranging from 10 to 50°C. It was found that high temperatures uncouple mitochondria. This was evident between 40 and 45°C where substrate oxidation increased but P/O values declined. At 50°C both respiration and phosphorylation were impaired, phosphorylation to the greater degree. Root mitochondria appeared to be somewhat more sensitive to high temperatures than were shoot mitochondria. Between 30 and 50°C, root mitochondria suffered 80% inhibition of phosphorylative efficiency, compared to 58% for shoot mitochondria. (P.C.H.)

6921 THE PRODUCTION OF CHROMOSOMAL ABERRATIONS BY STREPTONIGRIN IN VICIA FABA. B. A. Kihlman (Uppsala Univ.). Mutation Res., 1: 54-62(May 1964)

The radiomimetic (chromosome-breaking) effect of streptonigrin (SN) in the root-tips of Vicia faba is described and discussed in relation to the effects of other radiomimetic agents. A 1-hr treatment with 10^{-5} M SN induced subchromatid exchanges in early prophase cells and chromatid aberrations in cells that were in middle or late interphase. The effect of SN was not inhibited by anoxia or 2,4-dinitrophenol and very little influenced by temperature and pH during treatment. (auth)

6922 TRITIUM LABELLING OF ANTIBODIES. C.-G. Rosen, L. Ehrenberg, and G. Ahnstroem (Royal Univ. of Stockholm). Nature, 204: 796-7(Nov. 21, 1964).

It is noted that ethyl methane sulfonate (EMS) alkylates proteins. By varying the pH, it is possible to vary the pattern of the groups that are alkylated and in this way selectively tritium label groups of proteins. EMS and human globulin were incubated and tested for stability against hydrolysis and electrophoretic mobility. The immunological activity of the globulin was also examined. (J.R.D.)

6923 USE OF "REPORTER GROUPS" IN STRUCTURE-FUNCTION STUDIES OF PROTEINS. Merrill Burr and D. E. Koshland, Jr. (Rockefeller Inst., New York and Brookhaven National Lab., Upton, N. Y.). Proc. Natl. Acad. Sci. U. S., 52: 1017-24(Oct. 1964). (BNL-8330)

A new technique was developed for the correlation of function with structure in protein molecules. A group that is sensitive to changes in environment and that can transmit a signal to an appropriate detector is introduced into a specific position in the protein. This group may report changes in its environment caused either by direct interaction with substrate or by a conformational alteration in the protein structure. An application of this method is described in which the compound 2-bromoacetamido-4-nitrophenol is reacted with the methionine residue near the active serine of chymotrypsin. On mixing substrates and inhibitors with the modified protein, characteristic difference spectra are obtained. Some of the applications and limitations of the method are discussed. (auth)

6924 DNA SYNTHESIS IN ALVEOLAR CELLS OF THE MAMMARY GLAND: ACCELERATION BY OVARIAN HORMONES. Francesco Bresciani (Brookhaven National Lab., Upton, N. Y. and Univ. of Naples). Science, 146: 653-5 (Oct. 30, 1964). (BNL-8250)

In normal alveolar cells of the mammary gland of C3H/HeJ female mice, DNA synthesis lasts an average of 20.7 hours with a coefficient of variation of 26.6%. Treatment of the mice with 1 microgram of 17-β-estradiol and 1 milligram of progesterone per day for 3 to 4 days decreased the average duration to 10.7 hours and the coefficient of variation to 13.8%. (auth)

6925 MEDICAL USES OF Ca^{47}: SECOND PANEL REPORT. Report of the Second Panel on the Medical Uses of Ca^{47} held in Vienna, 9-11 September 1963. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 32. 1964. 206p. STI/DOC/10/32. $4.00; Sch 84,-; 24s.stg; F.fr.16,-; DM 14,-(IAEA)

Thirty-eight papers are included; separate abstracts have been prepared for each. (H.M.G.)

For abstracts of individual papers see: 6926, 6927, 6928, 6983, 6984, 6985, 6986, 6987, 6988, 6989, 6990, 6991, 6992, 6993, 6994, 6995, 6996, 6997, 6998, 6999, 7000, 7001, 7002, 7003, 7004, 7005, 7006, 7007, 7256, 7257, 7258, 7259, 7260, 7261, 7329, 7330, 7612, and 7835.

6926 DEVELOPMENTS IN TECHNIQUE. K. R. Corey, E. Greenberg, P. Kenny, J. S. Laughlin, M. Merlino, and D. Weber. p.1-3 of STI/DOC/10/32.

The use of CsI(Tl) crystals in assaying blood and urine samples is discussed. Tables are used to compare the sensitivities of the CsI(Tl) detectors with the NaI(Tl) well counter used previously. Results indicate an improvement by a factor of more than 3 over the conventional NaI(Tl) detector. Substitution of saliva samples for plasma samples in Ca metabolism studies is described. It is concluded that saliva may be a practical substitute for serum in the determination of the specific activity of Ca, and that combined with whole-body retention measurements, certain kinetic studies on out-patients are possible. (H.M.G.)

6927 THE USE OF THE HEG-SCANNER FOR WHOLE-BODY COUNTING. K. R. Corey, E. Greenberg, P. Kenny, J. S. Laughlin, M. Merlino, and D. Weber. p.5-9 of STI/DOC/10/32.

A high-energy gamma (HEG) scanner designed for detection of bone lesions was used to determine body retention of ^{47}Ca and ^{89}Sr. Retention in seven patients was studied simultaneously by excretion collections and whole-body counting after intravenous injection of ^{89}Sr or ^{47}Ca or both. There was excellent agreement between the two techniques. (H.M.G.)

6928 WHOLE-BODY COUNTING OF Ca^{47}. E. H. Belcher and R. A. Dudley. p.9-12 of STI/DOC/10/32.

The reliability of measuring ^{47}Ca retention by whole-body counting was investigated in two subjects injected intravenously with ^{47}Ca. The scanning procedure used yielded whole-body counting estimates of retention accurate within 2% between 2 hrs and one week. Further, it is suggested that ^{47}Ca losses in sweat may cause estimates of retention by collection of excreta to be in error by a few per cent. (H.M.G.)

Ecology

6929 (ORNL-3653) THE HERPETOFAUNA OF THE OAK RIDGE AREA. R. M. Johnson (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26, Subcontract No. 2284 with Tennessee Polytechnic Inst. 32p. Dep.; $2.00(OTS).

The herpetofauna of the Oak Ridge area was investigated to ascertain the kinds of amphibians and reptiles (herptiles) occurring in the area, to evaluate habitat preferences of the herptiles, to evaluate the suitability of the various species populations for ecological investigations, and to prepare a reference collection of herptiles of the area. Collecting was performed by prowling about the various kinds of habitats by day and by night and collecting by hand; walking transects by day and by night and collecting by hand; trapping with hardware-cloth drift fences and funnel traps in terrestrial habitats; using dipnet, funnel traps, and hoop nets in aquatic habitats; and driving roads by day and by night. The most productive method of collecting in terrestrial habitats and streams was hand collecting; in fluvial and pond habitats it was with dipnet, funnel trap, and hoop net. The numbers of monotypic species of herptiles collected are as follows: salamanders, 3; anurans, 2; turtles, 2; lizards, 4; and snakes, 2. The numbers of polytypic species collected are as follows (numbers in parentheses are subspecies represented): salamanders, 4 (4); anurans, 10 (12); turtles, 8 (10); lizards, 1 (1); and snakes, 15 (18). The largest numbers of species and specimens were collected in flood-plain and pond habitats; the least numbers were collected in pine plantations. Herptiles judged as occurring in populations of sufficient size, seasonal availability, and ease of sampling for extensive field and laboratory investigations are as follows: Desmognathus fuscus; Hyla versicolor; Acris crepitans; Rana clamitans; R. palustris; Chrysemys picta; Pseudemys scripta; Natrix septemvittata; and N. sipedon. (36 references.) (auth)

6930 (ORNL-3697(p.43-8)) MOVEMENT OF RADIONUCLIDES IN TERRESTRIAL ENVIRONMENT. T. F. Lomenick, Tsuneo Tamura, Ferrucio Gera, W. M. McMaster, R. M. Richardson, and D. A. Gardiner (Oak Ridge National Lab., Tenn.).

Core samples taken in and around waste pits show that most of the ^{137}Cs and ^{90}Sr is concentrated in sludge and precipitates in the pits and on the first few inches of shale comprising the side walls and bottoms of the pits. By the use of tritiated water as a tracer, it was observed that the normal rate of ground-water movement in the waste pit area is about 0.5 ft/day. Most of ^{137}Cs in the bed of White Oak Lake occupies highly selective exchange sites on the illitic clay fraction of the lacustrine sediment and can be desorbed only by disruption of the clay lattice structure. Analyses of selected samples obtained from the upper 0.2 ft of White Oak Creek bottom sediment indicate that less than 5×10^5 $\mu\mu c$ of ^{137}Cs and substantially smaller quantities of ^{60}Co and ^{106}Ru are stored in this zone. The inference is drawn that the residence time for the less-than-63-μ sediment in this zone is relatively short and that the material is scoured during higher-than-normal stages and transported into White Oak Lake. As an extension of information gained from laboratory studies on radionuclide sorption, field studies on deliberately contaminated plots, using ^{137}Cs, were started in order to correlate areal and vertical redistribution of the nuclide with natural factors, including biologic, meteorologic, and pedologic factors. (auth)

6931 (ORNL-3697(p.65-84)) RADIOACTIVE WASTE AREA AND RADIATION EFFECTS STUDIES. S. I. Auerbach, G. N. Brown, D. A. Crossley, Jr., et al. (Oak Ridge National Lab., Tenn.).

Statistical analyses of sedges growing on White Oak Lake bed indicated that length of inflorescence was mostly correlated with the air dose rate of gamma radiation at 1 m above ground surface. Some of the natural vegetation around the unshielded Health Physics Research Reactor exhibited the first visible effects of radiation damage. Radiation effects studies completed this year included fast-neutron exposures from the HPRR, and gamma-radiation exposures from both a ^{137}Cs field source and the White Oak Lake bed. Among the findings were that all acute fast-neutron doses ranging from 100 to 500 rads resulted in 100% mortality of pine seedlings. Pine seedlings subjected to chronic gamma irradiation from White Oak Lake bed for 178 days exhibited 100% needle mortality. A study was initiated to determine the seasonal changes in nuclear volumes of local tree species. Shoot apexes were measured monthly from 14 local species. An analysis of variance showed that most species increased in size before shoot elongation. Initial spring activity of nucleic acids in shoot apexes is thus earlier in eastern Tennessee than would be anticipated from any external evidence. Continuing work on the use of metaphosphate glass dosimeters demonstrated that low-Z glass rods are subject to fading in sunlight. Mud-dauber wasps that used radioactive mud from the liquid waste pits were found to be affected by the ionizing radiation. Continuing studies on radiocesium accumulation and elimination by various species of insects demonstrated the usefulness of these techniques for measuring food consumption and insect production under field conditions. Energy flow through the herbivorous insect population was estimated by using food consumption rates calculated with steady-state equilibria for radiocesium. Preliminary studies of radiation response of several insect species including crickets and grain beetles were reported. Hematological studies of native mammals were completed. The objective of these studies was to determine the effects of endogenous and environmental factors on the blood of indigenous species. These studies have shown that factors such as age, sex, certain diseases, certain parasites, injuries, confinement, and season govern hematopoietic changes. The largest and most consistent change in normal serum patterns is characteristically demonstrated by albumin. A coefficient of correlation of -0.360 between total white cell count and albumin–globulin ratio was calculated for the white-footed mouse ($0.05 > P > 0.02$). (auth)

6932 (ORNL-3697(p.85-94)) PROCESSES AND COMPONENTS OF TERRESTRIAL ECOSYSTEMS. J. S. Olson, G. N. Brown, G. M. Van Dyne, et al. (Oak Ridge National Lab., Tenn.).

An inventory of total ^{137}Cs distribution among the tree-soil compartments of the tagged tulip poplar ecosystem constructed from data collected during and at the end of the first growing season suggests that about 50% of the initial tag is found in the litter, soil, and smaller root components at the end of the first growing season. Accumulation of surface income of ^{137}Cs within the organic litter layer and surface 2 cm of soil was measured in sample units which prevented root entry. Results from these sample units indicate that half of the surface income was contained within the organic layer and more than 80% was contained within the organic layer plus the surface 2 cm of mineral soil. Sampling measurements indicated that 2.67 mc of ^{137}Cs was transported outside the study area by falling leaves. Transfers in young seedlings are rapid. Microbial uptake of stable cesium and cobalt was proportional to their concentrations in the environment over a concentration range of 2 to 3 orders of magnitude. There was no marked isotopic selection for either of these elements. Uptake of ^{134}Cs was proportional to the concentration of ^{134}Cs in the substrate. When microbes were separated from a tagged substrate by water, agar, or semipermeable film, microbial uptake was proportional to the concentration of ^{134}Cs in these intermediates. Microbial concentration factors for different substrates varied with the availability of the tag. On fresh-leaf litter with readily available cesium, microbial concentration relative to the substrate was twice as high as on weathered, old litter with less readily available cesium. (auth)

6933 (ORNL-3697(p.95-104)) CLINCH RIVER AND RELATED AQUATIC STUDIES. D. J. Nelson, S. I. Auerbach, B. G. Blaylock, et al. (Oak Ridge National Lab., Tenn.).

The series of analyses of stable strontium in white crappie flesh and bone was completed, and it was possible to test the relation of the distribution of stable strontium and ^{90}Sr between the environment and the fish. Uptake and accumulation of strontium and calcium by algae and snails representing contrasting types of biogeochemical systems are reported. There is an increase of newly occurring chromosomal aberrations in the natural population of Chironomus tentans from White Oak Creek. These newly occurring aberrations are eliminated by selection or genetic drift and are not maintained in the gene pool of the population. The increased mutation rate produced by the chronic irradiation in the White Oak Creek population has not reduced the amount of chromosomal polymorphism in this natural population. (auth)

6934 (ORNL-3697(p.104-9)) THEORETICAL SYSTEMS. B. C. Patten, J. S. Olson, and G. M. Van Dyne (Oak Ridge National Lab., Tenn.).

To provide a conceptual basis for understanding radiation effects and the fate of nuclides in ecosystems, analog computer solutions of competition equations, both with and without radiation stress, were generated. The equations investigated were the Lotka-Volterra system which has received major attention in classical population ecology. Introducing radiation stress in the form of a rarefying term in the equations altered both transient and steady-state responses of the system. Where the final result was determined in the unstressed cases only by the degree of competition between the two species, under radiation stress their respective reproductive potentials became an important factor. Previous compartment models for transfer of substances in ecological systems are generalized in the form of a system of differential equations. (auth)

6935 (ORNL-TM-997) DESIGN OF ^{90}Sr SOURCES FOR ECOLOGICAL STUDIES INVOLVING BETA IRRADIATION. E. F. Menhinick (Oak Ridge National Lab., Tenn.). Nov. 11, 1964. Contract [W-7405-eng-26]. 17p. Dep.(mn): $1.00(cy), 1(mn) OTS.

Three $^{90}Sr-^{90}Y$ sources containing 0.08, 0.8, and 8.0 C, respectively, giving surface dose rates of approximately 100, 1000, and 10,000 R/hr, respectively were designed for ecological studies. These sources will consist of $^{90}SrCl_2$ mixed with sodium silicate and painted on transite plaques which will then be placed in leak-tested aluminum source holders. These sources will be used for acute and chronic beta irradiations of insects, studies in radiation detection by insects, glass rod dosimetry research, and tissue absorption studies. (auth)

6936 GAMMA EMITTERS IN A FIN WHALE. Charles Osterberg, William Pearcy, and Norman Kujala (Oregon State Univ., Corvallis). Nature, 204: 1006-7(Dec. 5, 1964).

Tissue samples were obtained from a 55-ft male fin whale captured west of Depoe Bay, Oregon, on Sept. 19, 1963. These whales are collectors of marine zooplankton, which concentrate radioisotopes. ^{65}Zn was the most prominent peak in spectra of all the tissue analyzed. ^{40}K was next in prominence, followed by ^{54}Mn, ^{137}Cs, ^{95}Zr, ^{95}Nb, and $^{141-144}Ce$, in some tissues. In general, spectra of the tissue resembled those of small mesopelagic fishes from the same trophic level. (M.C.G.)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstract 7319.

6937 (ANL-6906(p.41-60)) TOXICITY AND METABOLISM OF RADIONUCLIDES. William P. Norris, Louise S. Lombard, Carl E. Rehfeld, and Robert J. Toft (Argonne National Lab., Ill.).

Pathological alterations are described that were observed in dogs 955 days after the injection of 50 $\mu C/kg$ of ^{144}Ce; 52 days after the injection of 2704 $\mu C/kg$ of ^{137}Cs; 38 days after the injection of 2650 $\mu C/kg$; and in nonradioactive dogs that died while on standard and semisynthetic diets. Pathological alterations are described that were observed in rats injected intravenously with ^{144}Ce at the $LD_{100/30}$ and other levels. Progress is reported in studies on the effects of ^{131}I on thyroid function in dogs. Data are included on the short-term uptake of ^{131}I by the thyroid, whole-body retention of ^{131}I, and excretion of ^{131}I in urine and feces. (C.H.)

6938 (ANL-6906(p.70-2)) EFFECT OF PUROMYCIN ON BLOOD AND LIVER CATALASE. Robert N. Feinstein, Judith B. Howard, and John E. Seaholm (Argonne National Lab., Ill.).

Puromycin (aminonucleoside) has been reported to inhibit protein synthesis. The effects of injected puromycin on blood and liver catalase activity in mice were investigated. Preliminary results indicate that puromycin affects the catalase activity of liver 2 to 5 days after injection but had little effect on the catalase activity of erythrocytes. When protein synthesis was significantly affected for a prolonged time, the effect on the animal was drastic. (C.H.)

6939 (ANL-6906(p.73-4)) LACK OF EFFECT OF EXOGENOUS CATALASE ADMINISTERED DURING PREGNANCY ON CATALASE CONTENT OF PROGENY. Robert N. Feinstein, John E. Seaholm, and Judith B. Howard (Argonne National Lab., Ill.).

Repeated injections of exogenous catalase, presumably giving rise to repeated high maternal blood levels, were without ultimate effect on the catalase level in blood or liver of progeny of female mice. (C.H.)

6940 (ANL-6906(p.81-4)) OCCASIONAL RESISTANCE OF MICE TO GLUCOSE OXIDASE INJECTION. Robert N. Feinstein and John E. Seaholm (Argonne National Lab., Ill.).

Results are reported from an investigation of the drastic effects of intraperitoneal injection into mice of the enzyme glucose oxidase, a mold-derived product catalyzing the reaction: glucose + oxygen → hydrogen peroxide + gluconic acid. These effects, which depend qualitatively and quantitatively upon the dose administered, include erythrocyte hemolysis, methemoglobin formation, striking changes in hematocrit, and death. It was observed that occasional animals, perhaps five per cent, appeared to be totally unaffected by the enzyme. Injection of as much as 100 lethal doses caused no blood changes or other signs of toxicity in these mice. The occasional striking resistance to injection of glucose oxidase seen in apparently normal mice cannot be explained either as an immunological or as a genetic phenomenon. (auth)

6941 (ANL-6906(p.90-1)) PROGRESS REPORT: PLUTONIUM REMOVAL. XI. REMOVAL OF POLYMERIC PLUTONIUM FROM MICE BY COMBINED THERAPY WITH THE CALCIUM CHELATE AND PENTAETHYL ESTER OF DTPA. Joan F. Markley (Argonne National Lab., Ill.).

Results are summarized from studies on the comparative effectiveness of the pentaethyl ester and the Ca salt of diethylenetriaminepentaacetic acid in the removal of a polymeric form of Pu from mice. (C.H.)

6942 (ANL-6906(p.93-100)) THE METABOLISM OF MITOCHONDRIAL PROTEINS. I. THE ISOZYMES OF GLUTAMIC-PYRUVIC TRANSAMINASE. Robert W. Swick, Paula L. Barnstein, and John L. Stange (Argonne National Lab., Ill.).

Progress is reported in studies of chemical characteristics of isozymes of glutamic-pyruvic transaminase. Measurement of enzyme activity in rats under various conditions of protein intake and corticosteroid administration showed that the enzymes do not always react in an identical manner to treatment of the host. Differences in the stability, methods of enrichment, pH optima, and kinetic constants strongly suggest that these are, indeed, isozymes of glutamic-pyruvic transaminase. A new technique for solubilizing mitochondrial enzymes was developed; the technique involves osmotic shock after partial replacement of water in the mitochondria with glycerol. (auth)

6943 (ANL-6906(p.102-5)) NUCLEAR CHANGES IN RAT LIVER CELLS DURING THIOACETAMIDE ADMIN-

ISTRATION. A. D. Barton and Elizabeth A. Cerny (Argonne National Lab., Ill.).

Results are reported from a study of the effects of the daily administration of thioacetamide on nuclear changes in rat liver cells. Increases in nuclear volumes, nuclear RNA content, and protein were observed while no change was noted in the amount of DNA per nucleus or in the amount of RNA per cell or gram of liver. (C.H.)

6944 (ANL-6906(p.106-9)) NUCLEAR CHANGES IN RAT KIDNEY CELLS AFTER CASTRATION AND ADMINISTRATION OF TESTOSTERONE. A. D. Barton and Kathleen M. Tracy (Argonne National Lab., Ill.).

Kidney cell nuclei were isolated from rats in which the testosterone balance was altered in various ways and changes in nuclear constituents that accompany changes in the level of testosterone activity were followed by direct measurements on the isolated nuclei. The testosterone balance was altered by castration, castration with testosterone treatment for 4 or 8 days, and normal rats treated with testosterone for 6 days. Results indicated that testosterone causes an increase in the size of kidney cells and their nuclei without changing the total number of cells present. (C.H.)

6945 (ANL-6906(p.113-17)) PHOSPHOLIPASE C, LOW pH, AND TEMPERATURE EFFECTS ON ACID PHOSPHATASE RELEASE FROM RAT LIVER, SPLEEN AND THYMUS. Y. E. Rahman (Argonne National Lab., Ill.).

Progress is reported in studies on the functional and physiological characteristics of lysosomes from rat liver, spleen, and thymus under the effects of phospholipase C, low pH, and different temperatures. (C.H.)

6946 (BNL-7725) THE INFLUENCE OF SUCROSE CONCENTRATION ON THE MINIMUM MITOTIC CYCLE DURATION OF ROOT MERISTEM CELLS IN VITRO. Jack Van't Hof (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Aseptically cultured roots of Pisum sativum were maintained in White's medium containing different percentages of sucrose. The minimum cycle time was least at 2 per cent and increased with either an increase or a decrease in sucrose concentration. The proportion of dividing cells increased after 12 hours in culture in a manner independent of the sucrose concentration provided it was near optimal (3, 2, or 1 per cent). At 6 per cent and at percentages less than 1 per cent the proportion of dividing cells increased less rapidly. This slower increase was associated with longer cycle duration. Comparison of the minimum cycle duration in 2 per cent sucrose immediately following excision and after 72 hours in culture, showed a decreased cycle duration in the older culture. (auth)

6947 (BNL-7745) THE ZINC PATHWAY THROUGH THE BODY: RECEPTORS FOR ZINC AND COMPETITION BY CADMIUM IN TISSUES. P. S. Papavasilious and G. C. Cotzias (Brookhaven National Lab., Upton, N. Y.). [Jan 17, 1964]. Contract [AT(30-2)-Gen-16]. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Following injection into intact mice, radioisotopes of zinc and of cadmium became bound to tissue receptors whose affinities for these metals varied over a large range. By fixing the experimental conditions, these receptors were divided into two sets, referred to as the exchangeable and the nonexchangeable fractions respectively. In spite of this arbitrary subdivision the behavior of these receptors as tested in vitro reflected several characteristic features of the physiological behavior of these metals within intact animals. (auth)

6948 (ORNL-3697(p.178-92)). STABLE ELEMENT METABOLISM. W. S. Snyder, Cyrus Feldman, Isabel H. Tipton, Mary Jane Cook, F. S. Jones, Jane J. Shafer, and Peggy L. Stewart (Oak Ridge National Lab., Tenn.).

The studies of trace elements in human tissues, diets, and excreta are partially complete. A distribution of stable strontium in the body is found to differ rather significantly from the distribution of ^{226}Ra under chronic conditions of exposure. About 99% of the stable strontium is in the skeleton, whereas the skeleton burden of ^{226}Ra due to the natural background is about 80% of the body burden. (auth)

6949 (ORNL-3697(p.193-8)) A TWO-COMPARTMENT MODEL WITH RANDOM VARIABLE FLOWS. S. R. Bernard and V. R. R. Uppuluri (Oak Ridge National Lab., Tenn.).

Since estimates of dose depend upon a metabolic model, a system of compartments is constructed which are connected during periods of time distributed randomly, thus simulating bone sites that may be remodeling during various periods of time. In a two-compartment model it is found that certain distributions of the time periods during which exchanges between compartments are permitted produce a power-function type of retention. (auth)

6950 THE ACCUMULATION AND LOCALIZATION OF RADIOACTIVE ^{60}COBALT IN RAT KIDNEY. A. Kasanen, Ilmari Lindgren, and Heikki A. Salmi (Univ. of Turku, Finland). Acta Physiol. Scand., 61: 376-9(1964).

Female Wistar rats were given $^{60}CoCl$ with a specific activity of 1 mC/20 μg. A dose of 100 μC dissolved in 0.5 ml of saline was injected into each animal. The rats were killed 4 hr to 24 days after the single injection. Cobalt-60 accumulation was followed in kidney using autoradiography. The radioactivity accumulated rapidly in kidney tissue, and its main site of localization was the renal cortex in the vicinity of the cortico-medullary zone, forming wedge-formed areas against the renal capsule. Most of the activity was in the tubules. No activity was observed in the medulla or the glomeruli. (BBB)

6951 PROTEIN METABOLISM IN PATIENTS WITH MULTIPLE MYELOMA. S. Korman and S. W. Lippincott (Brookhaven National Lab., Upton, N. Y. and Jewish Chronic Disease Hospital, Brooklyn). Acta Unio Intern. Contra Cancrum, 20: 1089-95(1964).

The metabolism of ^{131}I labeled myeloma beta globulin was compared to that of labeled normal and myeloma gamma globulin in patients with multiple myeloma. The biological half life ($T_{1/2}$) of ^{131}I labeled normal and myeloma gamma globulin in multiple myeloma patients with a hypergammaglobulinemia peak on paper electrophoresis was 7 days as compared to 17 days for the patients with a hyperbetaglobulinemia peak. Similarly labeled myeloma beta globulin was degraded faster in the hyperbetaglobulinemia patients than in a hypergammaglobulinemic patient. Since the rate of catabolism of the gamma globulin is accelerated in patients with hypergammaglobulinemia, it indicates a very high rate of synthesis to maintain the elevated serum concentration found in these patients. On the other hand, the slower rate of catabolism of the gamma globulin in the patients' hyperbetaglobulinemia indicates a decreased rate of synthesis of the gamma globulin, since these patients have a decreased serum globulin concentration. Urethane therapy was found to increase the catabolism of the globulins in the multiple myeloma patients. (auth)

6952 PROBLEMS OF GENERAL PHARMACODYNAMICS APPROACHED WITH THE AID OF RADIOSIOTOPES. Yves Cohen (Centre d'Etudes Nucléaires, Saclay, France). Actualities Pharmacol., 15: 45-98(1963). (In French)

An extensive review, referring to 320 references, is presented dealing with the use of isotopes in pharmacologic studies. The subject is limited here to the study of the absorption, transport, localization, and elimination of drugs. Of the molecules used in pharmacology, those marked with ^{14}C, ^{3}H, or ^{35}S are most easily synthesized and are the least expensive. Studies concerning the absorption and transport of drugs with the aid of radioisotopes have contributed to the clarification of these phenomena. Penetration of the skin by numerous lipid materials in which are incorporated tracer elements (^{131}I, ^{35}S), or combined with hydrocarbons (p-cymene-^{14}C), or with drugs shows that the route taken by the lipophilic substances is via the fatty formations of the epidermis. The absorption by the intestine can be explained in part by the phenomena of diffusion, the dependence of physical factors like lipid solubility, pH, the dissociation constant of the drugs, and the influence of the organic or inorganic ions. However, an active absorp-

tion process occurs with some substances, such as vitamin B_{12}. The medications, which have been absorbed are carried by the blood before being localized in the organs, and the labeled molecules permit certain factors influencing their transport to be observed during their distribution via the blood. According to its properties, the substance is carried in solution in the plasma, or it may be combined with serum protein; for example, the corticosteroids are less fixed to these proteins when the substitutions on the steroid nucleus are more numerous, while heparin is attached to well-defined fractions of serum proteins. There is often a marked difference between the plasma and cellular distribution of the isotopes appearing in blood. Estrone is adsorbed by the surface of the red corpuscles; $^2/_3$ of the triamcinolone is present in the plasma; and p-cymene is carried principally by the red cells. The isotopic study of vitamin B_{12}, antibiotics, and polyvinylpyrrolidone shows that the transport phenomena observed are very complex and do not depend solely on physical factors. The physiologic barriers opposing the invasion of organisms, for example, the placental barrier and the blood-brain barrier, have been more precisely described with the help of radioisotopes. Penetration of an organ by drugs does not depend directly on circulatory factors but also on homeostasis which plays an important role in acidosis in particular, which augments the penetration of phenobarbital, salicylic acid, and urea. The cerebral distribution of drugs can be transitory and uniform, such as with m-tolylquinazolone. In most cases the myelinization of nerve tissue increases the passage of active substances (phenobarbital, p-cymene) but phenothiazines have variable encephalotropic properties according to their chemical structure; the presence of a quaternary ammonium group in the molecule hinders passage into the brain. The action of these compounds on the penetrability of the blood-brain barrier was observed with the help of ^{32}P, acetate-^{14}C, and glucose-^{14}C. The liver and kidneys also present barriers which transform and eliminate certain foreign substances. The marked molecules make possible the determination of the metabolism of numerous drugs, and the establishment of their biological half times by measuring the rapidity of their excretion. All results obtained so far prove that the greatest part of the drug in question is concentrated in these organs and barely reaches the specific receptors which cause its pharmacological action. Some experiments with methyltolylquinazolone indicate that its fixation in excretory tissues precedes the fixation on the receptors. The use of radioisotopes has stimulated new hope for the precise localization of these receptors, but the actual tissue or cellular localization of numerous drugs (such as digitalis, antidiabetic agents, hormones, vitamins, antibiotics, and bactericidal agents) does not allow proof of their affinity for specific receptors except in two cases; the fixation of the curare has been proven to be at the level of the motor end plate, and that of a ganglioplegic agent at the sympathetic ganglion. The results so far obtained are encouraging in showing a close relation between the pharmacologic activity and specific localization. (BBB)

6953 EQUILIBRATION BETWEEN TISSUE CALCIUM AND INJECTED RADIOCALCIUM IN THE RAT. J. Mulryan, M. W. Neuman, W. F. Neuman, and T. Y. Toribara (Univ. of Rochester, N. Y. and Rockefeller Inst., New York). Am. J. Physiol., 207: 947-52(Oct. 1964).

The exchange of calcium in soft tissues was studied in normal and slightly hyperparathyroid, adult rats. Both chemical and radiocalcium assays were performed on a variety of tissues at periods from 10 min to 1 hr and also 1 to 4 days after ^{45}Ca injections. Bone, brain, tendon, and muscle were found to exchange quite slowly, requiring from several hours to several days to equilibrate with the circulation. On the other hand, skin, lung, heart, liver, uterus, and kidney showed specific activities equal to or greater than that of the circulating blood within 10 min. Thereafter, the specific activities of these tissues fell rapidly, approximating the rapidly decreasing specific activity of serum. No significant alterations in these patterns were caused by parathyroid extract. The general significance of this rapid exchange of calcium in many soft tissues is discussed. (auth)

6954 THE BIOLOGICAL HALF-LIFE OF MOLYBDENUM-99 IN NORMAL AND NUTRITIONALLY DEFICIENT COWS. G. A. Robinson, Anne McCarter, H. C. Rowsell, E. B. Meads, Patricia E. Riddell, and P. A. Taylor (Ontario Veterinary Coll., Guelph, Can.). Am. J. Vet. Res., 25: 1040-3(July 1964).

The secretion and excretion of a small load of ^{99}Mo-molybdate was investigated in six Holstein-Friesian cows from the herd at Ontario Veterinary College Research Station in late spring and in six Holstein-Friesian cows from a farm near Winchester, Ontario in early fall. The Winchester herd had been pastured on flat muck land and developed a debility characterized by reduced growth, low milk production, and low serum Cu levels. They were injected with ^{99}Mo-labeled $Na_2MoO_4 \cdot 2H_2O$, 55.4 to 57.5 mg in aqueous solution. The ^{99}Mo contents of urine collected at 2.5- to 9.0-hr intervals for 77.5 hr and of milk and feces collected during the period t = 47.5 to t = 71.5 hr were measured. Assuming an exponential function for urinary excretion of ^{99}Mo from t = 17.5 hr to the end of the investigation, the mean biological half-life for ^{99}Mo for the cows at the Ontario Veterinary College was 19.9 ± 1.4 hr. Mean body weight for these cows was 606 ± 15 kg; mean total exchangeable body Mo was 2.73 ± 0.58 mg per cow. Values for the Winchester cows were 18.7 ± 1.2 hr, 432 ± 21 kg, and 12.5 ± 2.2 mg per cow, respectively. Results are not strictly compared because the Winchester cows are pregnant, but they are considered indicative of Mo involvement in the nutritional problem in the Winchester area. The debilitated condition of the Winchester cows was improved by feeding Cu salts. However, the relatively high total Mo content of the urine and the higher total exchangeable Mo content of the Winchester cows suggested that a major nutritional factor contributing to the small size and the lower milk production of Winchester herds was not Cu deficiency but Mo excess. Studies of the Mo content of foliage of the general area did not support this view. (BBB)

6955 UPTAKE OF CALCIUM-45 BY RAT DIAPHRAGM IN VITRO. Jean C. Landgraf, H. D. Jackson, H. E. Parker, and W. J. Tietz (Purdue Univ., Lafayette, Ind.). Arch. Biochem. Biophys., 108: 386-9(Dec. 1964).

Rat diaphragm tissue accumulated calcium during incubation in bovine blood plasma to a greater degree than may be attributed to diffusion and exchange alone. The calcium content of diaphragm tissue was increased from 99 to 200 ppm during a 40-minute incubation at 37°C in bovine plasma containing 82 ppm calcium. The calcium uptake was not greatly influenced by the addition of parathyroid extract to the incubation medium, and accumulation of calcium by diaphragm tissue from thyroparathyroidectomized rats followed the same trends as the accumulation by tissue from the intact animals. (auth)

6956 THE WHOLE BODY RETENTION MEASUREMENT AS A SENSITIVE AND EXACT TEST FOR THE QUANTITATIVE DETERMINATION OF THE INTESTINAL RESORPTION. I. THE RADIO-VITAMIN-B_{12} RESORPTION WHOLE BODY RETENTION TEST. H. C. Heinrich and E. E. Gabbe (Universität, Hamburg). Atompraxis, 10: 477-85(Nov. 1964). (In German)

For the exact quantitative measurement of the intestinal resorption of radionuclides or compounds labeled with gamma-emitting radionuclides, the radiometric determination of the resorbed substance is an ideal test-method for diagnostic examinations and scientific questions. By use of large-volume radioactivity detectors with liquid organic scintillators and 4 π-volume angle utilization of sensitivity in radiation measurement of 2 to 3×10^{-10} C ^{60}Co is possible for the ^{60}Co-vitamin-B_{12} resorption whole-body retention test. The additional radiation burden (0.05 mrem/week) of a diagnostical radio-vitamin-B_{12} resorption whole-body retention test is only 1% of the natural radiation burden of 5 mrem/week and thus within its range. To compute the radio-vitamin-B_{12} whole-body retention, which corresponds with the intestinal radio-vitamin-B_{12} resorption, the

total of four measurements of about 5 minutes is sufficient. The background radioactivity of the body, the total radio-vitamin-B_{12} test quantity after oral administration, the whole-body 100% reference value after 10 to 24 hr, and the ^{60}Co radioactivity resorbed and retained in the whole body (4th measurement) after 7 days were determined. The quotient of the last two measurements multiplied by 100 is the intestinal resorbed and in the whole-body retained ^{60}Co-vitamin-B_{12}. (auth)

6957 EFFECT OF CALCIUM LEVEL IN THE SUBSTRATE ON THE DISTRIBUTION OF ^{45}Ca IN SUBTERRANEAN CLOVER (TRIFOLIUM SUBTERRANEUM L.). C. R. Millikan and B. C. Hanger (Victorian Dept. of Agriculture, Burnley, Victoria, Australia). Australian J. Biol. Sci., 17: 823-44(Nov. 1964).

Calcium level in the substrate was found to have a very marked effect on the distribution of ^{45}Ca in subterranean clover. Sites of initial accumulation of ^{45}Ca included the vein endings along the distal margins of the leaflets, the lateral veins, and the proximal halves of the petioles. In plants with a normal calcium supply these sites were quickly saturated and the isotope became uniformly distributed in the lamina, which contained a higher concentration than its associated petiole. There was a positive correlation between leaf age and ^{45}Ca concentration. In the petiole a somewhat higher concentration of ^{45}Ca finally occurred in the distal when compared with the proximal half. Calcium-deficient plants differed in that, with the exception of the vein endings, the initial sites of accumulation of ^{45}Ca were not rapidly saturated. In the lamina ^{45}Ca moved into the interveinal tissues adjacent to the vein endings. Provided acute calcium-deficiency symptoms did not occur, there was finally a build-up of ^{45}Ca in the distal half of the petiole. The concentration in the petiole was greater than in the lamina. Before runner-stem formation began there was not the same correlation in deficient plants between leaf age and ^{45}Ca concentration as in normal plants, indicating that much of the newly absorbed ^{45}Ca was acquired by young leaves of deficient plants at the expense of the oldest. This resulted in petiole collapse in old leaves due to the lack of build-up of calcium concentration in the distal halves of the petioles. The development of marginal necrosis of youngest leaves due to calcium deficiency was associated with a further disorganization of ^{45}Ca distribution. ^{45}Ca accumulated in epidermal hairs and flowers. Translocation of ^{45}Ca into new leaves and flowers produced up to 9 weeks after transfer from radioactive low-calcium solutions to non-radioactive normal- or low-calcium solutions was demonstrated. This mobile calcium came mainly from root tissue. (P.C.H.)

6958 STUDIES ON THE INHIBITION OF INTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM. The Effect of Administration of Sodium Alginate in Food and in Drinking Water. D. Waldron-Edward, T. M. Paul, and S. C. Skoryna (McGill Univ., Montreal). Can. Med. Assoc. J., 91: 1006-10(Nov. 7, 1964).

A method is reported that permits selective suppression of absorption of radioactive strontium from ingested food material, permitting calcium to be available to the body. Studies were carried out by measuring bone uptake of ^{89}Sr and ^{45}Ca when various amounts of sodium alginate were fed with the diet. Long-term studies were made in which two different levels of radioactivity were used to determine the pattern of ^{89}Sr deposition with continuous intake of binding agent. It was found that administration of sodium alginate as a jelly overcomes the problem of constipation and effectively reduces ^{89}Sr uptake, up to 83%. This fact represents a significant finding with respect to the use of the compound in human subjects. Addition of sodium alginate to drinking water is effective with low levels of ^{89}Sr intake. (P.C.H.)

6959 EFFECT OF SULPHATES ON THE INTESTINAL ABSORPTION OF Sr-85 IN RATS. V. Volf (Inst. of Industrial Hygiene and Occupational Diseases, Prague). Experientia, 20: 626-7(1964).

The effects of various sulfates on the metabolism of orally administered ^{85}Sr in rats was compared. In femurs of rats receiving Na, Mg, Ca, and Ba sulfates, 40 to 60% less ^{85}Sr was retained, whereas strontium sulfate reduced the skeletal retention by only 30%. Following the administration of barium sulfate combined with sodium sulfate, the skeletal retention of ^{85}Sr was reduced by 90 and 50% in starved and fed animals respectively. When treatment was delayed its effect decreased with time. (M.C.G.)

6960 METABOLISM OF HUMAN STH LABELED WITH ^{131}I IN SUBJECTS WITH CHRONIC HEPATOPATHY. A. Isnori, O. Recchia, and L. Rascio. Folia Endocrinol., 17: 363-71(1964). (In Italian)

The life span of ^{131}I-labeled STH, both in normal subjects and in patients with liver cirrhosis, was studied. The research was performed in order to evaluate the role played by the liver parenchyma in the metabolic fate of the hormone. Moreover, the rate of disappearance of the latter was evaluated in comparison with data previously observed in patients suffering from typical somatotropinic pathology. The researches were assessed in four cirrhotic patients without ascites, and comparatively in two normal subjects. 5 gamma/kg of ^{131}I-STH were administered intravenously; from 10 min to 8 hr after the injection, the total plasma radioactivity and the trichloroacetic-acid (TAC)-precipitable, were determined. The curve of disappearance of the TAC-precipitable radioactivity could be clearly divided into two phases, one of which was faster, falling between 1 min and 60 min and a second one, more prolonged. The first phase was considered as a distributive phase, and the second as metabolic. The mean-life time in the first phase was nearly the same both in normal and pathologic subjects ($T_{\frac{1}{2}}$ = 20 min 5 sec ± 2 min 5 sec and $T_{\frac{1}{2}}$ = 28 min 5 sec ± 3 min 3 sec), while the mean-life period in the second phase is much more prolonged in the pathologic subjects ($T_{\frac{1}{2}}$ = 420 min ± 0) than in normal ones ($T_{\frac{1}{2}}$ = 315 min ± 67 min 3 sec. The results suggest that, owing to the hepatic damage, the impairment of the protidopoiesis leads to remarkable alteration of the metabolic activities of STH, while its activation processes and the peripheral utilization are deeply damaged. (P.C.H.)

6961 ACTION OF $CaNa_2$ EDTA ON THE KINETICS OF THE DISTRIBUTION AND EXCRETION OF LEAD (^{210}Pb) ACETATE IN THE RAT. N. Castellino and S. Aloj (Università, Naples). Folia Med. (Naples), 47: 381-403(Apr. 1964). (In Italian)

The distribution and excretion of ^{210}Pb was studied in the rat under the action of $CaNa_2$ EDTA (ethylenediaminetetraacetate). This chelating agent was given intravenously, in doses of 50 mg/rat at varying intervals after intravenous injections of ^{210}Pb acetate in doses of 100 μg Pb/rat. The results showed that, by giving the chelating agent, the elimination of ^{210}Pb in the urine is increased, while elimination in the feces is reduced. The increase in urine ^{210}Pb levels was found to be high in animals treated at short intervals after the injection of Pb, and continued decreasing until it disappeared altogether in subsequent treatments. $CaNa_2$ EDTA mobilized Pb from all tissues, except bone tissue. The distribution curves of ^{210}Pb are expressed by a sum of two exponential functions. As in the case of animals which were not treated with the chelating agent, there was evidence of an initial phase of rapid elimination of Pb, followed by a slower phase. The interpretation of the results suggests that $CaNa_2$ EDTA is distributed in the extracellular liquids in which it will have a chelating effect on Pb ions which are removed from the cells, so that their passage into the plasma and thence into the urine will be accelerated. The chelating agent changes the equilibrium between the cellular and extracellular compartments, but does not penetrate the cells and therefore fails to mobilize the Pb which is bound to or transformed into organic compounds. A study was also carried out on ^{210}Pb distribution and elimination following administration of Pb acetate per oz in doses of 500 μg Pb/rat. These studies were carried out on two groups of animals, the first being treated for some days before, and the second during the test with $CaNa_2$ EDTA mixed in drinking water in concentrations of 1%. The results showed that there was no significant difference between the two groups of animals with regard to

the quantities of ^{210}Pb absorbed through the intestine (~ 18%), eliminated through the feces (~ 66%), and present in the gastrointestinal tract (~ 16%). On the other hand, the animals treated with the $CaNa_2$ EDTA showed a significant increase in ^{210}Pb urine excretion (5.06% as compared with 0.80% in control animals) and a reduction (statistically non-significant) in ^{210}Pb percentages which were fixed to the tissues. (BBB)

6962 COMPARATIVE STUDY ON THE LABELLING OF MICROORGANISMS WITH SELENIUM-75. J. Sternberg and A. Mercier (Universite, Montreal). Intern. J. Appl. Radiation Isotopes, 15: 587-98(Oct. 1964). (In French)

When ^{75}Se is added as a mineral salt to a sauton culture medium, it is taken up in significant proportion by B.C.G. The amount of stable selenium added to the culture medium does not inhibit the microbial growth. Selenium is incorporated into sulfur-containing microbial constituents, chiefly amino acids, and less in the lipidic material. It does not seem to exist in a specific selenium-containing compound. A fraction of protein-bound selenium is extracted with water or buffers at an alkaline pH. However, the largest proportion of selenium remains firmly bound to the cellular proteins, from which it is released only after a prolonged hydrolysis. The high uptake of selenium did not seem to be peculiar to B.C.G., but rather a biochemical phenomenon common to other living cells faced with two periodic relatives, one with a more accentuated biological role than the other. Selenium seemed to compete successfully with sulfur in crossing the cell membrane, and once in the cytoplasm, it was preferentially incorporated into the sulfurated amino acids. The physical characteristics of ^{75}Se, together with its firm binding to the microbial cell, indicated that microbial labeling with ^{75}Se should be an adequate procedure for investigations in vivo with tagged microbes. (auth)

6963 FUNDAMENTAL STUDIES ON THE CONTAMINATION OF MILK BY RADIOACTIVE STRONTIUM SPECIALLY, EFFECTS BY INTERNAL EXPOSURE OF β-RAY. Akira Yuyama. Iwate Daigaku Nogakubu Hokoku, 6: 285-98(Mar. 1963). (In Japanese)

An investigation was made to determine the function of mammary glands and the growth of suckling young animals by internal exposure of β rays, when milk was contaminated by a large quantity of radioactive strontium. Both ^{32}P and ^{90}Sr, beta sources, were injected intraperitoneally into lactating mice immediately after delivery. ^{32}P was administered only once, and ^{90}Sr repeated once each day. In one group administered 10 $\mu C/g$ ^{32}P, the weight of mammary glands decreased remarkably. Atrophy and flatness of the glandular epithelia were recognized, and the nuclei were pycnotic or had been destroyed. Growth of the suckling young nursed by those mice was remarkably inferior to that of the control group, and the growth stopped from the 12th day after delivery. In a group administered 5 $\mu C/g$ ^{32}P the effects were almost identical with those above, but the young did not stop growing. Injury of mammary glands in the group administered with 1 $\mu C/g$/day ^{90}Sr was very remarkable and the glandular epithelia lost their normal form. Body weight of the suckling young decreased suddenly from the 13th day after delivery and many died. (P.C.H.)

6964 ON CERTAIN REGULARITIES ON THE PLANT UPTAKE OF THE SECOND-GROUP ELEMENTS OF THE MENDELEEV PERIODIC TABLE. A. L. Kovalevskii (Inst. of Scientific Research in Geology, Geochemistry, and Mineral Resources, Novosibirsk, Siberia). Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser., Biol.-Med. Nauk, No. 4, 53-61 (1963). (In Russian)

The accumulation of Be, Mg, Ca, Zn, Sr, Cd, Ba, Hg, and Ra were studied. All the elements accumulate in woody plants to approximately the same degree as in the soil. Usually in the ash of old organs their contents are 2 to 10 times greater than in the soil. No dependence of the biological absorption coefficient on the atomic number was observed. Selectivity of element absorption by different species increased with increase in the atomic number. Plants may be characterized by their radium contents, and independently of their growth conditions. The ratio of the contents of these elements in the young and old organs of woody plants in the first part of the vegetative period regularly decreased with increase in atomic number but toward the end of the vegetative period tended toward equalization. (tr-auth)

6965 PROSTAGLANDINS AND RELATED FACTORS. 27. SYNTHESIS OF TRITIUM-LABELED PROSTAGLANDIN E_1 AND STUDIES ON ITS DISTRIBUTION AND EXCRETION IN THE RAT. Bengt Samuelsson (Karolinska Institute, Stockholm). J. Biol. Chem., 239: 4091-6(Dec. 1964).

The synthesis of tritium-labeled prostaglandin E_1 is described. The excretion of isotope after administration of tritium-labeled prostaglandin E_1 to rats occurred both in urine and in feces. After 40 hours, about 50% of the administered dose was recovered in urine and about 10% in feces. Rats with cannulated bile ducts excreted comparative amounts of the isotope in urine and bile. Following administration of tritium-labeled prostaglandin E_1 to rats, the concentration of isotope in various tissues was determined. High concentrations of isotope were observed in the kidneys and the liver. Intermediate concentrations were found in the lungs, pituitary gland, adrenals, ovaries, uterus, and heart and low concentrations in the brain, muscle, adipose tissue, and thymus. The labeled products appearing in urine, plasma, liver, and kidney after administration of tritium-labeled prostaglandin E_1 were characterized by chromatography. Labeled 11α, 15-dihydroxy-9-ketoprostanoic acid and 11α-hydroxy-9,15-diketoprostanoic acid were found in plasma. (auth)

6966 SOME FACTORS AFFECTING IODINE SECRETION IN MILK. J. K. Miller and E. W. Swanson (Univ. of Tennessee, Oak Ridge). J. Dairy Sci., 46: 927-32(Sept. 1963).

A series of experiments was conducted to study the manner in which iodine enters cows' milk: Eight cows averaging 23.2 lb milk daily were paired with their identical twins in later lactation averaging 10.7 lb. ^{131}I was administered intravenously followed by seven-day collection periods. Milk secretion was stopped in the left udder halves of eight cows by allowing a 24-hr accumulation of milk, and the right halves were milked prior to intravenous administration of ^{131}I. Right and left udder halves were milked at 8- and 32-hr intervals thereafter for six days. ^{131}I was infused into the gland cisterns of six cows after the morning milking. Absorption of administered ^{131}I from the mammary gland into the blood stream was estimated from the percentage of the dose recovered in the milk during subsequent milkings. Results indicate that iodide passes easily in both directions between the cow's mammary gland and blood, and that it can enter the milk independent of milk secretion. Protein-bound iodine did not appear to transfer between blood and milk in either direction. It was indicated that iodide enters the cow's udder passively (regardless of secretory activity), but that once it is in the milk-collecting spaces, a portion of the iodine is bound in some manner and is not available for resorption. The greater iodine secretion of higher-yielding cows is related primarily to their greater volume of milk. (auth)

6967 THE LOSS OF ANTIBODY TITER FOLLOWING LABELING BY TRITIUM GAS EXPOSURE. David E. Schlegel (Univ. of California, Berkeley). J. Immunol., 93: 566(Oct. 1964).

Attempts were made to produce ^3H-labeled antibody by exposure of antirabbit goat globulin to T gas by the Wilzbach method (J. Am. Chem. Soc., 79: 1013(1957)). The globulin was exposed to T gas at 0°C for 10 days. In later experiments this procedure was modified; the sample was exposed to 1.0°C of T under silent electrical discharge for varying periods of time (15 to 0.5 min). A substantial incorporation of T was obtained in all experiments. The frozen-dried globulin was resuspended in water and labile T removed by precipitation of the globulin with Na_2SO_4. The precipitate was resuspended in saline and dialyzed against more saline to remove excess Na_2SO_4. No attempt was made to determine sp. act. after precipitation and dialysis.

Comparisons were made between the antibody titers of tritiated and control globulin against normal rabbit serum on agar diffusion plates. A total loss of antibody titer was found even after the shortest period of exposure to T. The titer of the control globulin samples remained high. The globulin sample exposed to T gas for 10 days at 0°C and the sample exposed for 15 min in a silent electrical discharge were badly denatured and did not resuspend well. It appears then that antibodies are denatured during exposure to T under these conditions. Therefore, if radioactively labeled specific antiserums are to be used in the detection of viruses or other antigens in tissues, other more gentle means of labeling will have to be found. (BBB)

6968 AN EXPERIMENTAL STUDY OF TISSUE-CONCENTRATION RATIOS OF As^{74} ARSENATE AND LABELED ORGANIC CONJUGATES. J. Donald McQueen and John L. Mego (Baltimore City Hospitals and Johns Hopkins Univ., Baltimore). J. Neurosurg., 21: 641-6(1964).

The levels of ^{74}As in tissue were studied in tumor-bearing mice after intravenous injections of inorganic material and several organic preparations. Pentavalent organic arsenicals were notable because of their scanty passage into brain; tumor-to-brain ratios of concentration were higher than those found with inorganic material. A possible application for radioencephalographic scanning or scintillation photography is suggested. Steep curves of clearance of inorganic and organic arsenic in tumor were compared with an uprising pattern of assimilation for azopolylysine which paralleled that noted (previously with arsonoazoalbumin. The amounts of these two macromolecules in tumor were in the same range. (P.C.H.)

6969 SELENIUM-75 METABOLISM IN THE GESTATING EWE AND FETAL LAMB: EFFECTS OF DIETARY α-TOCOPHEROL AND SELENIUM. P. L. Wright and M. C. Bell (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). J. Nutr., 84: 49-56(Sept. 1964).

This study was designed to separate the effects of dietary selenium and of α-tocopherol on the metabolism of selenium in the gestating ewe and fetal lamb. A purified ration utilizing urea as the sole source of nitrogen was used to avoid a protein source which would contribute significant amounts of selenium or unsaturated fats. Selenium and α-tocopherol were added separately and in combination to this basal ration. Serum glutamic oxaloacetic transaminase (SGO-T) in young pregnant ewes was increased after the animals had received the α-tocopherol-deficient ration for 9 weeks; selenium delayed but did not prevent this increase. No changes in SGO-T values were observed in the aged ewes during the 18-week experimental period. Selenium supplementation reduced the apparent absorption of an oral dose of ^{75}Se and increased the urinary ^{75}Se excretion. Very high concentrations of ^{75}Se were noted in kidney and spleen samples from the selenium-deficient ewes, implicating these tissues as prime areas of importance in selenium metabolism. Intracellular particulate matter separations revealed an increase in ^{75}Se content of the liver microsomes and kidney nuclei in tissues from selenium-deficient ewes. The ^{75}Se distribution pattern in fetal tissues was similar to that in maternal tissues. A definite placental barrier was observed, with single fetuses having twice the concentration of ^{75}Se as twin fetuses. The expected severe gross pathologic lesions of α-tocopherol and selenium deficiency were not observed in these studies based on a ration which was low in unsaturated fat and therefore not highly auto-oxidizable. The data suggest that α-tocopherol may directly or indirectly affect the passage of selenium across cellular and subcellular membranes, and they support the hypothesis that selenium is activity metabolized and may have specific metabolic functions within the cell. (BBB)

6970 THE DAILY INTAKES OF MANGANESE AND IRON BY JAPANESE PEOPLE WITH REFERENCE TO MARINE ENVIRONMENTAL CONTAMINATION WITH RADIOISOTOPES. Noboru Yamagata (Inst. of Public Health, Tokyo) and Toshiko Yamagata. Koshu Eiselin Kenkyu Hokoku, 13: 11-20(Mar. 1964).

Measurements were made of manganese and iron in complete diet samples collected from many sites to learn the normal daily ingestion of these elements by the average Japanese. Two-thirds of urban adults would take 1.5–2.8 mg (2.12 mg, on an average) and 9–30 mg (19.2 mg); rural adults, 2.0–3.0 mg (2.50 mg) and 9–27 mg (18.0 mg) of manganese and iron respectively. The average daily intakes by Japanese adults as a whole were roughly estimated as 2.3 mg and 19 mg of manganese and iron respectively. The main contributors of manganese are plant products, especially cereals, both in Japan and in the United States. Iron is evenly contributed by different categories of foodstuffs in Japan. This contrasts with a typical diet in the United States in which almost half the iron is contributed by meat, eggs, and milk. The concept of an average concentration factor of an element in sea water and in seafood was introduced to permit evaluation of the marine environmental contamination with radioisotopes and make possible the planning of radiological protection of people. (Public Health Eng. Abstr., 44: No. 10, Oct. 1964)

6971 ACTIVE TRANSPORT OF ALKALINE EARTH IONS AS PHYSIOLOGICAL BASE OF THE ACCUMULATION OF SOME RADIONUCLIDES IN FRESHWATER MOLLUSCS. O. Van der Borght and S. Van Puymbroeck (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Nature, 204: 533-4 (Nov. 7, 1964).

To verify the existence of active transport of calcium ions against an electrochemical potential gradient in freshwater mollusks, concentrations of calcium and strontium were measured for Lymnaea stagnalis (L.). The total concentration of calcium in the blood averaged 150 to 200 mg/l, but a net uptake of calcium was possible if only 5 mg/l calcium are present in the water. Four groups of 10 L. stagnalis were placed in 200 ml of water containing 40 mg/l calcium and 5 mg/l (Sr + ^{85}Sr). The blood contained no measurable strontium before the experiment. After 48 hr, the radioactivity of the blood in these animals, corresponding to 14 mg/l (Sr + ^{85}Sr), was four times higher than that of the surrounding water. These results indicated active uptake. Studies with ^{133}Ba also gave the same indications. (M.C.G.)

6972 CHROMOSOMAL PATTERNS IN CANCER PATIENTS DURING TREATMENT. Anthony P. Amarose (Albany Medical Coll., N. Y.). N. Y. State J. Med., 64: 2407-13(Oct. 1, 1964). (TID-20666)

A study was made on chromosomes in patients with cancer, principally carcinoma of the lung, who were undergoing radiotherapy. The therapy consisted of treatment with 2 Mev x rays, ^{60}Co teletherapy, and sometimes a combination of one of these with various antitumor agents. Data were acquired on studying the chromosomes of cultured leukocytes obtained from the patients' peripheral blood. The results showed that damage appeared to be largely random in the chromosomes affected in the different cancers, and the specific aberrations differed from cell to cell. However, there seemed to be some correlation between the appearance of persistent aberrant chromosomes and their frequency. (P.C.H.)

6973 TRANSFERENCE OF Sr-89 AND Ca-45 FROM EGG SHELL TO EGG CONTENTS AND EMBRYO. F. R. Mraz and P. E. Waibel (Univ. of Tennessee, Oak Ridge). Poultry Sci., 43: 1065-6(July 1964).

Studies were conducted to determine if radionuclides could penetrate the egg shell and become available to the embryo either from a topically applied solution or from the outer portion of the shell as deposited by the hen. White Leghorn eggs were immersed 30 sec in solutions containing 14 μC ^{45}Ca, 7 μC ^{89}Sr, and 4.2 μC ^{133}Ba per ml, with and without added detergent (0.05% Alconox). The following conditions were tested: eggs and solutions at 25°C; eggs at 25°C and solutions at 2°C; or eggs at 2°C and solutions at 25°C. Following immersion, the wet eggs were allowed to dry. Measurable quantities of the radionuclides were not found in the contents of the eggs or the embryos even after the 20-day incubation period, although appreciable amounts (as high as were present in 0.75 ml of the dipping solution) were found on the shells. It is concluded that the radionuclides did not penetrate the shell deeply enough to become available to the growing embryo. In further experiments hens were administered 70 μC ^{45}Ca and 35 mC ^{89}Sr intra-

muscularly at 5, 10, and 15 hr after oviposition; eggs laid the following day were incubated for 20 days. The results showed that less of the ^{45}Ca and ^{89}Sr from the shell was utilized by the embryo when the chickens were injected later (15-hr) during shell formation. This indicates the embryo's inability to utilize the minerals in the outer layers of the shell for its growth and that these minerals do not exchange readily with those contained deeper in the shell. (BBB)

6974 EFFECT OF SOME PROTECTIVE AGENTS ON THE OXYGEN LEVEL IN ANIMAL BRAIN TISSUE. R. B. Strelkov (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya, 4: 756-9(1964). (In Russian)

The effects of radioprotective agents on the oxygen tension in brain tissue were studied in 640 male and female white mice weighing 18 to 22 g. The sulfur-containing agents cystamine, aminoethylisothiourea (AET), and β-mercaptoethyleneamine (BMEA) decreased the oxygen level to 5 to 10% below normal, and thiourea and unithiol increased it to 3 and 15%, respectively, above normal. The amine derivatives adrenalin, methoxytryptamine, serotonin, and adrenalin in combination with acetylcholine increased the oxygen up to 25%, while histamine and acetylcholine decreased it 5 to 10%, and barbamyl 25%. Physiological saline had little effect (about 1% increase). The amine derivatives that increased the oxygen level in the brain also caused hypoxia in the spleen. Since the amines that increased the brain oxygen level have a pressor effect, it is suggested that with the spasm in the peripheral vessels, there is an expansion in the brain at the same time. The data verify earlier observations that showed differences in the action of amine derivatives and sulfur-containing protective compounds. (TTT)

6975 COMPARATIVE EFFECTIVENESS OF SOME COMPLEXANTS IN REMOVING ^{239}Pu FROM ANIMAL ORGANS. Yu. A. Belyaev. Radiobiologiya, 4: 760-3(1964). (In Russian)

Data are presented on the rate of removal of ^{239}Pu from the kidneys, liver, spleen, and skeleton of rats by complex-forming compounds. Rats weighing 170 to 190 g were injected intraperitoneally with plutonium citrate (0.8 to 1.0 μC per animal), and the complexant was given parenterally at various times up to 30 days thereafter. The compounds were: $CaNa_2$-salt of triethylenetetraaminohexaacetic acid (TTHA); CaNa-salt of triethylenepentaaminoheptaacetic acid (TPHA); $CaNa_2$-salt of tetraacetic acid-2,2-diaminodiethyl sulfide (TS); and $CaNa_5$-salt of diethylenetriaminopentamethyl phosphinic acid (DTPPA). The strongest compound was TTGA, being several times more effective than DTPA with which other complexants are compared. TPGA was several times weaker than TTGA but still stronger than DTPA. The weakest was TS. DTPFA removed Pu from soft tissues and skeleton, but in general was somewhat weaker than TTGA, TPGA, and DTPA. If medical treatment is started 30 days after the Pu is given, the effectiveness of TTGA does not differ from that of TPGA and DTPA. (TTT)

6976 GROSS BODY COMPOSITION AS A FUNCTION OF CHRONOLOGIC AGE. Teruo Nagai, Takeshi Iinuma, and Tomio Ishihara (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 13: 477-83(Nov. 1964).

Volunteers from 6 to 89 years were assayed for ^{40}K in the large plastic scintillator human counter. The results obtained appear to suggest some interesting possibility for the study of gross body composition. The method is worthy of further study as a practical method of evaluating the aging process in large population groups. (auth)

6977 METHODS FOR THE STUDY OF IONIC METABOLISM BY RADIOACTIVE ISOTOPES. M. B. Francois. Rev. Lyon. Med., 13: 479-88(May 15, 1964). (In French)

A critical study on the methodology of exploration of ionic metabolism by radioisotopes is presented. Consideration is given to: modalities and distribution factors of radioactive ions; reference criterions; morphological (weight) and functional (phases and distribution masses); constraints and limitations of techniques; and metabolic conditions. (P.C.H.)

6978 THE CHANGES IN INFRARED SPECTRA OF THE EVACUATED BRAIN TISSUE OF A WHITE RAT. A. I. Sidorova and I. N. Kochnev. Vestn. Leningr. Univ., No. 16, Ser. Fiz. i Khim. No. 3, 38-41(1964). (In Russian)

Changes in the infrared spectra of the brain of a white rat were investigated after samples of the brain tissue were dehydrated by vacuum pumping. Deuterium oxide metabolism studies had been made on the brain tissues previously. (P.C.H.)

6979 DISTRIBUTION OF RADIOYTTRIUM AND RADIOACTIVE RARE EARTHS IN MAMMALS. PART IV. METABOLISM INVESTIGATIONS WITH RADIOPRASEODYMIUM (^{143}Pr) IN MICE. Friedrich Gensicke and Gisela Henneberger (Deutsche Akademie der Wissenschaften, Berlin). Z. Naturforsch., 19b: 893-9(Oct. 1964). (In German)

The resorption, organ accumulation, and secretion of ^{143}Pr after injections in mice are reported. Radiopraseodymium in the form of praseodymium chloride was resorbed only very slowly, and was accumulated predominantly in the liver and skeleton. By addition of inactive isotopic carrier material as well as variation of the pH of the injection solution, the metabolism of ^{143}Pr could be plainly influenced. The results were compared with those obtained after applications of ^{144}Ce, ^{90}Y, and ^{91}Y. (tr-auth)

6980 ^{137}CESIUM BODY BURDEN AND ITS VARIATION IN 23 NORWEGIAN SCHOOL BOYS. Kjell Madshus (Norsk Hydros Inst. for Cancer Research, Oslo) and Aksel Stroemme. Z. Naturforsch., 19b: 1055-7(Nov. 1964).

Twenty-three boys from a school in Oslo, born in the years 1945, 1946, and 1947, were studied with regard to their ^{137}Cs body burden and potassium content. Their average ^{137}Cs body burden increased from 24.2 nC in March 1963 to 46.1 nC in October 1963 and then more slowly to 49.3 nC in March 1964 (or in the ratio $^{137}Cs/K$ 178, 338, 357, respectively). The ^{137}Cs body burden which was relatively high compared to what was found in other countries was partly due to the high concentration of ^{137}Cs in the milk. Those with a large milk consumption seemed to have somewhat higher ^{137}Cs body burdens than the others. (auth)

6981 THE INFLUENCE OF I CONTAINING CONTRAST MEDIA ON THE I RETENTION OF THE THYROID. E. Lorenz. Thesis, Berlin, Universität, 1963. 67p. $2.00 (Gmelin, AED-DISS. 63-620). (In German)

The influence of 2 types of x-ray contrast media (urographine and biligraphine) on I retention was studied by means of labeling with ^{132}I and ^{131}I. A significant retention inhibition, which lasts longer than 100 days, was observed. Possible mechanisms of thyroid blocking are discussed. (Gmelin Inst.)

6982 COMPARATIVE PATHOLOGY OF THE THYROID. Aubrey Gorbman. p.32-48 of "The Thyroid." Baltimore, Williams and Wilkins Co., 1964.

A review on the pathology of the thyroid included discussion on endemic thyroid faults, such as dietary factors, and invasive organisms, laboratory experiments on ^{131}I pathology, and normal developmental, functional, and anatomical features in lower vertebrates that have counterparts in human pathology, such as thyroid agenesis, benign metaplasia and metastasis, lateral aberrant (ultimobronchial) thyroid, colloid degeneration, and functional depression. Special consideration is given to early experiments on fish. 60 references are included. (P.C.H.)

6983 COMPLEXED CALCIUM AND THE EVALUATION OF TRACER KINETIC STUDIES: A REVISED COMPARTMENTAL MODEL. N. Veall and V. Parsons. p.12-17 of STI/DOC/10/32.

A model for Ca kinetics is presented that divides body Ca into compartments along recognized lines. The several chemical forms of Ca in plasma (ionized, protein-bound, and complexed) are discussed in terms of the model. It is suggested that calcium pools exist which contain calcium that is neither metabolically available nor readily exchangeable with radiocalcium. (H.M.G.)

6984 STABLE Ca^{48} AS A TRACER IN STUDIES OF MINERAL METABOLISM IN MAN. D. McPherson. p.17-20 of STI/DOC/10/32.

Enriched ^{48}Ca was given in parallel with ^{47}Ca to two human subjects. The resulting increase in abundance of ^{48}Ca in Ca isolated from urine samples was determined by mass spectrometry and neutron activation analysis and compared with control values derived from ^{47}Ca activity in percentage of dose per gram of natural Ca. The removal of Na during the isolation of Ca from urine was checked on other samples using tracer Na. No interference was encountered from Na in the samples during abundance estimation by either activation analysis or mass spectrometry. (H.M.G.)

6985 THEORY OF ALKALINE EARTH METABOLISM. The Bauer-Carlsson-Lindquist Equation Provides a Unifying Basis for Kinetic Analysis. J. H. Marshall. p.21-33 of STI/DOC/10/32.

A way was found to generalize the Bauer-Carlsson-Lindquist equation so that it is no longer restricted by a particular model. The rate A and the quantity E were given operational definitions that are applicable to any data for serum specific activity and retention. These definitions contain the current definitions as special cases, so involve no essential change in the current values or interpretations of these parameters. Simple expressions for A and E are presented which should help to shorten and to standardize calculation. (auth)

6986 CALCULATION OF BONE FORMATION RATE BY CURVE ANALYSIS. H. Glass. p.34-7 of STI/DOC/10/32.

Calculations of bone formation rate were made on the basis of a model consisting of a two-compartment system in which extracellular fluid Ca, much of the intracellular Ca, and the rapidly exchanging bone mineral represent the first compartment. (H.M.G.)

6987 CALCIUM TURNOVER STUDIES WITH INTRAVENOUSLY INJECTED Ca^{47}. E. H. Belcher, R. Fraser, D. H. Gutteridge, G. F. Joplin, and C. J. Robinson. p.37-43 of STI/DOC/10/32.

A method is presented for computing and analyzing calcium turnover in tracer studies using ^{47}Ca. (H.M.G.)

6988 CALCULATION OF CALCIUM ACCRETION RATE IN MAN. J. Tołwinski. p.43-6 of STI/DOC/10/32.

A method described for calculating Ca accretion rates in man is based on the difference between an injected dose of ^{47}Ca and the total excretion divided by the time integral of the plasma specific activity. Results were in good agreement with accretion rate calculations derived by the method of Wendeberg. Advantages and disadvantages of the method are discussed. (H.M.G.)

6989 CALCULATION OF BONE FORMATION AND RESORPTION RATES BY CONTINUOUS FEEDING OF Ca^{47}. B. E. C. Nordin, D. A. Smith, and J. Nisbet. p.47 of STI/DOC/10/32.

A formula was derived for determining bone resorption rate (BRR) with ^{47}Ca from the difference between dietary and plasma specific activities. Results obtained generally agreed very closely with those obtained by conventional calculation of BRR. (H.M.G.)

6990 STUDY OF Ca METABOLISM IN THYROID DISORDERS BY MEANS OF Ca^{47}: ANALYSIS OF KINETIC DATA. R. J. Soto, A. Rejtman, and I. Rozados. p.48-50 of STI/DOC/10/32.

Following the administration of ^{47}Ca, serum specific activities were plotted for eight patients. Equations were derived for determining total specific activity up to four days. (H.M.G.)

6991 Ca^{47} IN CLINICAL STUDIES OF BONE PHYSIOPATHOLOGY. A. Dhem. p.50-5 of STI/DOC/10/32.

Calcium-45 radioautography of caudal vertebrae in adult cats was used to study the histological distribution of the tracer in bone. From comparison of radiographs of proximal and distal vertebrae, tracer distribution was related to specific activity of the tissue. Implications of the study for clinical use of ^{47}Ca are discussed. (H.M.G.)

6992 NORMAL CALCIUM KINETICS: APPLICATION OF A NEWLY DERIVED COMPOSITE REFERENCE STANDARD. R. P. Heaney. p.57-61 of STI/DOC/10/32.

Radiocalcium studies in 30 normal adults were used to construct a composite reference standard for radiocalcium plasma decay and excretion. Recent studies of human tissue Ca equilibrium and exchange permitted construction of a reasonable, two-compartment open system that precisely fits the data of this reference standard. Plasma specific activity from 5 to 150 hr after isotope injection exhibited a highly significant inverse correlation with body size, but could not be correlated with age or sex. (H.M.G.)

6993 Ca^{47} IN THE INVESTIGATION OF RICKETS. R. Hoffenberg, F. Harris, and E. Black. p.61-9 of STI/DOC/10/32.

Calcium-47 was administered to rachitic children under different metabolic conditions. Regular plasma, urinary, and fecal stable Ca and P were determined for the period of study. Rachitic infants showed smaller Ca pool sizes than normal infants. Treatment of rachitics with Vitamin D increased pool size. Low accretion rates appeared in rachitic infants. These, however, were elevated by Vitamin D therapy, even in the presence of low Ca intake. Plasma clearance studies in rachitics showed slow clearing of ^{47}Ca after intravenous injection, a condition corrected by Vitamin D administration. (H.M.G.)

6994 CALCIUM KINETICS IN PARATHYROID DISEASE. J.-F. Dymling. p.69-74 of STI/DOC/10/32.

Calcium kinetics were studied in twelve cases of parathyroid disease using ^{85}Sr and ^{47}Ca as tracers. The data suggest that hyperparathyroidism usually causes increased bone turnover. To study calcium kinetics may be a valuable tool in the differential diagnosis of primary hyperparathyroidism and in evaluating treatment of secondary hyperparathyroidism. The bone turnover in one case of hypoparathyroidism was extremely low. (auth)

6995 BONE FORMATION AND RESORPTION RATES IN VARIOUS CLINICAL STATES. B. E. C. Nordin, H. Glass, D. Smith, J. MacGregor, J. Nisbet, and H. G. Burns. p.75-86 of STI/DOC/10/32.

Clinical uses of ^{45}Ca, ^{47}Ca, and ^{85}Sr were applied in determining bone formation and resorption rates. Bone formation rates ranged from 2 to 14 mg per kg per day and were unrelated to Ca balance, whereas bone resorption rates ranged from zero to about 22 mg per kg per day and were inversely related to Ca balance. High correlation existed between Ca balance and the urinary/dietary specific activity ratios, suggesting that bone resorption is inhibited by positive Ca balance produced by high Ca intakes. (H.M.G.)

6996 STUDY OF CALCIUM METABOLISM IN THYROID DISORDERS BY MEANS OF Ca^{47}: RESULTS. R. J. Soto, A. Rejtman, and I. Rozados. p.86-91 of STI/DOC/10/32.

Groups of normal individuals and hyperthyroid, hypothyroid, hypoparathyroid and osteoporotic patients were studied with intravenously injected ^{47}Ca. The size of the exchangeable calcium pool, the accretion rate and the excretion rates in urine and feces were determined. Calcium, phosphatase, citrate, and plasma protein levels in blood and calcium levels in urine were measured. No balance studies were performed. Hypothyroid patients did not show significant changes in pool size or in the accretion and excretion rates compared with normal subjects. Hyperthyroid patients showed significant increases in pool size and in accretion and excretion rates, and this phenomenon was also observed in cured thyrotoxic patients six months to one year after the disease was considered cured. Eight patients received ^{47}Ca orally, and in these an attempt was made to determine at the same time oral absorption as well as pool size, accretion and excretion rates. Results in these studies were inconclusive. (auth)

6997 CONTRIBUTION TO THE STUDY OF CALCIUM METABOLISM DURING DIFFUSE RARIFYING OSTEOPATHIAS USING Ca^{47}; COMPARATIVE STUDY OF THE EFFECTS OF THREE ANABOLIZING STEROIDS. B. Delaloye. p.91-102 of STI/DOC/10/32.

The variations in the amounts of rapidly miscible calcium were studied in normal subjects, in untreated osteoporosis patients, and in three groups of osteoporosis patients treated with three anabolic steroids. Compared with a normal subject, the osteoporotic manifests no large variations in the rapidly miscible calcium level, whereas this level is distinctly higher in osteomalacics. The rapidly miscible calcium values undergo no significant change after treatment with anabolic agents. When measuring the bromium space, it is proposed that a distinction be made between the rapidly miscible calcium of the extra-cellular liquid and that of the pre-osseous compartment. (auth)

6998 CALCIUM ABSORPTION TESTS USING ORAL Ca^{47}. C. J. Robinson, D. H. Gutteridge, G. F. Joplin, E. H. Belcher, and R. Frazer. p.119-24 of STI/DOC/10/32.

Solutions containing ^{47}Ca and stable strontium gluconate were given to fasting patients. Serum ^{47}Ca levels, urinary specific activity, and fecal ^{47}Ca were measured. Low serum values were found in patients with severe untreated malabsorption, severe thyrotoxicosis, hypopituitarism, and high steroid dosages, and high values in patients where calcium deficiency was likely, in particular in some patients with post-menopausal osteoporosis. Very similar information was given by the serum level and urinary specific activity measurements. Whole-body counts done on the 7th or 9th day were usually proportional to the early serum levels with the notable exception of two patients with untreated malabsorption and osteomalacia and one with remitting severe thyrotoxic osteoporosis. In these three patients the whole-body count was unusually high in relation to the early serum levels. (H.M.G.)

6999 STUDIES WITH A RADIOCALCIUM AND RADIOSTRONTIUM ABSORPTION TEST. B. E. C. Nordin, D. A. Smith, J. MacGregor, and J. Nisbett. p.124-7 of STI/DOC/10/32.

The effects of Ca carrier on ^{45}Ca and ^{85}Sr concentrations in blood were studied. Increased carrier tended to depress 2-hr activity of both isotopes. In the case of ^{85}Sr a progressive fall in 2-hr plasma activity appeared with increasing carrier concentrations to 750 mg. It is suggested that the same progression is a likely characteristic of ^{45}Ca also. Correlation between net Ca absorption and the radiocalcium test was determined to be 0.58. The relation between ^{85}Sr and ^{45}Ca or ^{47}Ca activity at 2 hrs after simultaneous injection was plotted. (H.M.G.)

7000 STUDIES OF ABSORPTION OF ORALLY ADMINISTERED CALCIUM. R. Hoffenberg, F. Harris, and E. Black. p.127-9 of STI/DOC/10/32.

Calcium-47 absorption following oral administration was studied in controls, in rachitic infants, and in rachitic infants treated with vitamin D. It was concluded that the higher plasma figure in rickets after oral ^{47}Ca is largely due to slower accretion. This supports conclusions drawn from the behavior of intravenous ^{47}Ca. (H.M.G.)

7001 ENDOGENOUS FAECAL CALCIUM. R. P. Heaney. p.129-31 of STI/DOC/10/32.

Endogenous fecal calcium was measured in 52 adult human subjects under conditions allowing full metabolic balance control. Total intestinal calcium secretion (TIC) was calculated. It was concluded that TIC is primarily determined by body size and is effectively unrelated to the state of Ca metabolism on the opposite side of the intestinal mucosa. (H.M.G.)

7002 ENDOGENOUS FAECAL CALCIUM, TOTAL DIGESTIVE JUICE CALCIUM AND UTILIZATION OF INTESTINAL CALCIUM. R. Hoffenberg, F. Harris, and E. Black. p.131-5 of STI/DOC/10/32.

Studies performed in rachitic infants indicate that Ca utilization is low in rickets and is improved by vitamin D. High phosphate feeding reduced utilization. Endogenous fecal excretion (EFC) as determined from plasma specific activity was increased by vitamin D therapy in rachitics and by phosphate supplementation of low calcium diets in normal infants. Conclusions concerned with total digestive juice calcium (TDJC) were difficult to draw, but vitamin D appeared to promote a distinct increase in TDJC in rachitics maintained on normal diets. (H.M.G.)

7003 DETERMINATION OF DIGESTIVE JUICE CALCIUM AND "TRUE" CALCIUM ABSORPTION. B. E. C. Nordin. p.135-40 of STI/DOC/10/32.

Net Ca absorption and true Ca absorption were calculated in 18 patients given 5 μC of ^{47}Ca intravenously and observed for 21 days. Endogenous fecal calcium ranged from about 2 to 6 mg per kg per day and digestive juice calcium from about 3 to 8 mg per kg. True absorption ranged from about 20 to 60%. There was a very high correlation between net and true absorption. (H.M.G.)

7004 COXARTHROSIS IN MAN STUDIED WITH EXTERNAL COUNTING OF Sr^{85} AND Ca^{47}. G. Heripret, L. G. Danielsson, and J.-F. Dymling. p.141-4 of STI/DOC/10/32.

This investigation of coxarthrosis has demonstrated a positive correlation between the results of external counting and the anatomical condition as judged by radiological examination: even in cases with slight anatomical changes and no clinical symptom, the H/K-ratio was higher than normal. Moreover, departures from this general tendency between the increased rate of metabolism and the anatomical condition of the hip, H/K-ratios significantly higher or lower than expected respectively in coxarthrosis of recent origin or long standing, suggest that it might be possible to evaluate the dynamics of the evolution of some cases of coxarthrosis. It should be emphasized that active osteoarthritis may complicate evaluation of external counting when used for studies of localized lesions like metastatic cancer. (auth)

7005 Ca^{47} STUDY OF POST-TRAUMATIC OSTEOPOROSIS IN THE ADULT MALE. A. Dhem, A. Vincent, and L. Coutelier. p.145-7 of STI/DOC/10/32.

Reactions of damaged bone were studied using ^{47}Ca. About 50 μC of ^{47}Ca were administered intravenously to patients suffering from open or closed fractures of the two bones of the leg. Results were recorded with a scintillation counter. Osteogenesis was determined to be more extensive in the metaphysics in which osteoporosis is occurring than in the metaphysis serving as control. (H.M.G.)

7006 THE TURNOVER OF Ca^{47} AND Sr^{85} IN BONE LESIONS. K. R. Corey. p.148-52 of STI/DOC/10/32.

External counting measurements of local ^{47}Ca and ^{85}Sr uptakes and turnover in normal bones and in bone metastases were done. In many studies serum samples and excretions were collected and assayed. It was found that the measurements on biological retention in normal bones can be expressed as a sum of two expoentials between 4 and 175 d after injection. The serum specific activity between 4 and 10 d could also be fitted by one of these exponentials. These and other results demonstrate that a two-compartment model is useful for the interpretation of data. Such analysis of measurements on lesions with elevated uptakes revealed detectable abnormalities in tracer turnover. Evidence of high accretion rate was observed in blastic lesions. The change in turnover in the lytic lesion was complex. These data illustrate a new approach for the study in vivo of calcium metabolism in healthy and diseased bones. (auth)

7007 CALCULATIONS OF CALCIUM KINETICS: INTERLABORATORY COMPARISON. J.-F. Dymling. p.169-78 of STI/DOC/10/32.

A study was carried out to compare the results of calculations of calcium kinetics made by nine investigators and presented at the panel. There was generally good agreement among the results. To all contributors except Glass the data indicated increased accretion rates and increased exchangeable spaces in roughly the same proportions. (H.M.G.)

Radiation Effects

7008 (ABCC-00-63) BIBLIOGRAPHY OF PUBLISHED PAPERS OF THE ATOMIC BOMB CASUALTY COMMISSION. (Atomic Bomb Casualty Commission, Hiroshima). 1963. Contract [AT(49-1)-Gen-72]. 6p. Dep. (mn); $1.00(cy), 1(mn) OTS.

A total of 43 references is presented to papers on medical effects of nuclear explosions which were published in the latter part of 1962 and in 1963. Subject and author indexes are included. (D.L.C.)

7009 (AD-600299) THE EFFECT OF TOTAL BODY IRRADIATION ON IMMUNOLOGIC TOLERANCE OF BONE MARROW AND HOMOGRAFTS OF OTHER LIVING TISSUE. Final Report, February 1, 1963–January 31, 1964. Vincent P. Collins (Baylor Univ., Houston, Tex. Coll. of Medicine). 48p. $4.60(OTS).

The effects of total body irradiation on 112 adults with disseminated cancer are summarized. The data have been collected over a ten year period. Tables are presented showing the dose rate, the time intervals between irradiation, and the survival time of the patients. The reaction of white blood cells and granulocytes following varying radiological doses and the effect of bone marrow injections following irradiation are described with case histories, charts, and graphs. An annotated bibliography containing 78 reports selected from a review of more than 600 reports lists the organism used in the study, the amount of radiation used, and the findings for each of these reports. This literature search covers the period through 1962. (auth)

7010 (AD-602135) CHRONIC EFFECTS OF IONIZING RADIATION ON THE HEMATOPOIETIC SYSTEM. Final Technical Report. Charles E. Brambel (University of Notre Dame, Notre Dame, Ind.). July 1, 1964. Contract DA-49-007-MD-955. 497p. $6.00(OTS).

The cellular and biochemical basis for the cumulative damage manifested in the immature and mature female rats during their maintenance in the selected low level gamma radiation environments were studied. Frequent quantitative measurements were made of the cellular composition of blood and blood forming tissues and of the major protein components of serum. Massive recovery of splenic erythropoiesis under continuous radiation exposure in the absence of marrow recovery was noted. This pointed to a potential role of the spleen for survival under the experimental conditions used, and comparisons of splenectomized with nonsplenectomized animals were also performed. Experiments have been started to provide information on post-radiation survival after continuous exposure to ascertain late effects of radiation including stress situations such as heat and cold. (auth)

7011 (AED-C-04-14) RADIATION EFFECTS ON LIVING TISSUES AND ORGANISMS. Series C: Bibliographies. W. Stahlhofen, comp. (Max-Planck-Institut für Biophysik, Frankfurt am Main). Apr. [1964]. 145p. Dep. (mn).

Approximately 450 references are presented to publications since 1961 on radiation effects on living tissues and organisms. Author, subject, and report number indexes are included. (C.H.)

7012 (ANL-6906(p.7-18)) RADIATION MORTALITY IN THE MOUSE: KINETICS OF INJURY ACCUMULATION DURING PROTRACTED EXPOSURES IN THE SUPRALETHAL RANGE. S. Phyllis Stearner and Margaret H. Sanderson (Argonne National Lab., Ill.).

A kinetic description is presented of radiation injuries in mice associated with lethality expressed within 9 days after exposure to a single protracted dose of ^{60}Co γ radiation. An empirical mathematical model was used that describes the accumulation of lethal injury during irradiation by two postulated processes, the first dependent on exposure time and reversible and the second independent of exposure time for periods at least through 24 hr and irreversible. The role of bacteremia, functional failure of the hematopoietic system, damage to intestinal epithelium, and the excessive loss of water and electrolytes with resultant fluid imbalance in radiation lethality are considered. (C.H.)

7013 (ANL-6906(p.23-6)) EFFECTS OF HIBERNATION ON THE LATENT PERIOD IN NORMAL AND X-IRRADIATED GROUND SQUIRRELS. Bernard N. Jaroslow and Douglas E. Smith (Argonne National Lab., Ill.).

Results are reported from a study of the immune responses in hibernators. The disappearance of ^{131}I-labeled bovine serum albumin (BSA) from the circulation of ground squirrels, Citellus tridecemlineatus was used as the test system. Results indicate that antigen disappearance is much slower in hibernating than in non-hibernating ground squirrels. That the events of the latent period can take place during hibernation is shown by the lack of a post-hibernation latent period in some of the animals that hibernated for 56 days. The normal posthibernation latent period observed in some of the squirrels that entered hibernation 4 or 6 days after antigen injection indicate that events of the latent period, initiated before entry into hibernation, could be completely or partially abrogated in as short a period as 18 days in hibernation and that the processes of induction recurred upon arousal. X irradiation with 450 R inhibited the synthesis of antibody in all groups. Those that produced antibody did so only after a delay, a response that is typical of irradiated animals. It was apparent that a 2-week hibernation period interposed between irradiation and antigen injection did not result in any detectable recovery. Irradiation after induction occurred usually did not result in the inhibition of antibody production. Some of the animals were rendered anergic when irradiated 2 weeks after antigen injection. This suggests that the events of the latent period may have gone full cycle during hibernation, so that, at the time of x irradiation, induction had not recurred. The rapid drop in circulating antigen immediately after irradiation and arousal was undoubtedly an effect of irradiation and not of arousal, as can be seen from a comparison with other groups injected with BSA or with normal serum. (C.H.)

7014 (ANL-6906(p.75-7)) SEARCH FOR AN ACATALASEMIC MOUSE. Robert N. Feinstein, John E. Seaholm, and Judith B. Howard (Argonne National Lab., Ill.).

By means of a rapid, semiquantitative assay, approximately 5600 progeny of irradiated mice were examined for low blood catalase. Of these, 14 were selected as subnormal in blood catalase activity. Of the 14, one is almost surely a heterozygote, and some of the others may be. The feasibility of this approach in obtaining specific mutants for the study of inborn errors of metabolism is discussed. (C.H.)

7015 (ANL-6906(p.85-6)) MUTATION INDUCED WITH CAFFEINE, ULTRAVIOLET LIGHT, OR 2-AMINOPURINE. Herbert E. Kubitschek and Harold E. Bendigkeit (Argonne National Lab., Ill.).

Progress is reported in studies on the effects of growth rate on the mutational responses of Escherichia coli to caffeine, ultraviolet light, or 2-aminopurine. (C.H.)

7016 (ANL-6906(p.110-12)) EFFECT OF X-RADIATION ON OXIDATIVE PHOSPHORYLATION IN RAT LIVER MITOCHONDRIA. [PART] II. John F. Thomson and Sharron L. Nance (Argonne National Lab., Ill.).

Results are summarized from a series of studies on the effect of x radiation on oxidative phosphorylation in mitochondrial fractions isolated from the livers of male or female rats. Data are presented on oxygen consumption, phosphate esterification, P/O ratios, and total nitrogen in different mitochondrial fractions obtained under a variety of experimental conditions. (C.H.)

7017 (BNL-7727) THE DESIGN AND CALIBRATION OF AN X-RAY BEAM FACILITY FOR RADIOBIOLOGIC STUDIES ON MAMMALIAN NERVOUS TISSUES. Arland L. Carsten and W. Zeman (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 19p. Dep. (mn); $1.00(cy), 1(mn) OTS.

A method is described for controlling source- and target-dependent variables during the exposure of animals in a series of radiobiologic studies. Several hundred rats

were irradiated and irradiation effects were reproducible within a narrow range. Data are presented to illustrate the importance of controlling physical factors to reduce what might be mistakenly thought of as biological variability. If results between different laboratories, and indeed even within the same laboratory are to be compared, the importance of precise control of physical and biological dependent variables then becomes obligatory. This can be approximated and achieved with the technique described. (auth)

7018 (BNL-8675) CHANGES IN THE STRUCTURE OF AN OAK-PINE FOREST EXPOSED FOR TWO YEARS TO CHRONIC GAMMA IRRADIATION (thesis). Allen Laverne Rebuck (Duke Univ., Durham, N. C.). 1964. Contract AT-30-2-GEN-16. 97p. Dep.(mn); $3.00(cy), 2(mn)OTS.

The changes in the structure of a Long Island oak-pine forest induced by ionizing radiation were studied. Since November 22, 1961, the forest has been exposed for twenty hours each day to gamma radiation from 9500 curies of ^{137}Cs. Permanent plots located around the source in concentric rings were used to make an inventory prior to irradiation, and annually since, of all plants 1 m tall and taller, and to sample the lower vegetation. A coding system was used to record height, diameter, and vigor of individual trees in each plot, the data being tabulated by machine. About 35 species of higher plants occurred in the four strata of the forest prior to irradiation. The dominant species were: Quercus alba, Q. coccinea, and Pinus rigida in the tree layer; Quercus ilicifolia in the high-shrub layer; Gaylussacia baccata and Vaccinium vacillans in the low-shrub layer; and Vaccinium angustifolium and Carex pensylvanica in the ground-cover layer. Differential damage to the major species by radiation produced a series of zones around the source by the spring of 1962. This zonation has remained since then, most of the zones becoming wider as the area of effects has extended outward from the source. In general, the zones are correlated with the vegetation stratification. It is predicted that they will be maintained so long as radiation continues. (auth)

7019 (LADC-6168) THE ABSENCE OF AVOIDANCE RECOGNITION BY THE MOUSE SUBJECTED TO CHRONIC INVARIANT γ-RAY EXPOSURES. J. C. Hensley and J. F. Spalding (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Mice were allowed the freedom of position choice in a cage-run assembly during a 32-day exposure to chronic invariant γ-rays with a dose rate range of between 7.6 and 1.2 Rads/hr to determine the possibility of radiation recognition and avoidance. Individual $AgPO_3$ glass dosimeters implanted in the mice were used to determine the average source-to-specimen distance during the 32-day exposure period. Recognition by avoidance was not indicated, but rather the average source-to-specimen distance indicated a positive tendency toward positions closer to the source. (auth)

7020 (TID-17942) BIBLIOGRAPHY OF PUBLICATIONS CONCERNING EFFECT OF NUCLEAR EXPLOSIONS, 1945-1960. (Atomic Bomb Casualty Commission, Hiroshima). Contract [AT(49-1)-Gen-72]. 191p. Dep.(mn); $5.00(cy), 3(mn) OTS.

A bibliography is presented which includes 2409 references taken from the Atomic Bomb Casualty Commission Library, Japana Centra Revuo Medicine, Abstracts of Internal Medicine and Pediatrics from Japanese Journals, Quarterly Cumulative Index Medicus (Chicago), Current List of Medical Literature (Washington), etc. Author and subject indexes are included. (D.L.C.)

7021 (TID-20082) GENE NUMBER, EFFECT, AND MUTATION RATE FOR BODY WEIGHT IN TRIBOLIUM CASTANEUM. Alan C. Bartlett and A. Earl Bell (Purdue Univ., Lafayette, Ind.). [nd]. Contract AT(11-1)-965. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In a study of selection and x radiation, body weight of the grain beetle, Tribolium castaneum, was estimated to be controlled by 607 pairs of genes. Each gene locus was estimated to have an average phenotypic effect of 0.0046 mg. The radiation-induced mutation rate of these quantitative genes was of the magnitude of 10^{-4} to 10^{-5} mutations/roentgen/gene locus. (auth)

7022 (TT-1149) CHANGES IN THE PERMEABILITY OF BARRIERS AFTER IRRADIATION RADIOBIOLOGY OF THE CELL BARRIERS. B. Glukhovskii. Translated by H. R. Hayes (National Research Council of Canada, Ottawa), from Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 147-53(1963). 9p.

A review is presented of recent literature on the effects of ionizing radiation on the permeability of cell membranes. Emphasis is placed on observations made with the electron microscope and measurements of the content of K in irradiated and normal muscle fibers and cell membranes. It is concluded that the effects of radiation are not well defined but that radiation damage of membranes plays an important part in the development of radiation sickness. (C.H.)

7023 (UCRL-11614) REVERSIBLE AND IRREVERSIBLE EFFECTS OF IONIZING RADIATIONS ON THE REPRODUCTIVE INTEGRITY OF MAMMALIAN CELLS CULTURED IN VITRO (thesis). Paul Wilson Todd (California, Univ., Berkeley. Lawrence Radiation Lab.). Aug. 18, 1964. Contract W-7405-eng-48. 152p. Dep.(mn); $5.00(cy), 3(mn)OTS.

The colony-forming ability of human kidney T1 cells and Chinese hamster M3-1 cells cultured in vitro was studied after exposure to x rays and high-energy ions of ^{2}D, ^{4}He, ^{7}Li, ^{11}B, ^{12}C, ^{14}N, ^{16}O, ^{20}Ne, and ^{40}Ar under aerobic and anoxic conditions. The cytogenetic, radiobiological, and physiological properties of the progeny of single irradiated cells from both lines were studied. Both lines of cells were found to be maximally sensitive to fast ^{12}C ions that have LET of 2200 Mev-cm^2/g. Survival curves obtained at LET less than that of ^{12}C ions appeared sigmoid, whereas all others appeared exponential. Anoxic dose reduction decreased systematically from about 2.8 for x rays to 1.0 for fast ^{16}O ions. The T1 cells that had incorporated 5-iododeoxyuridine into their DNA were not sensitized to the effect of ^{12}C ions on their colony-forming ability. The progeny of single cells that formed abnormally small colonies following exposure to 500 Rads of x rays grew more slowly, consumed less oxygen, were more sensitive to subsequent radiation exposure, and appeared cytogenetically similar to the unirradiated parent-cell line. These observations suggest that the response to ionizing radiation of the reproductive capacity of cultured mammalian cells can be divided into three independent parts: irreversible and lethal; reversible and sublethal; and irreversible and sublethal. Reversibility, as used here, refers to the ability of the cells to actively recover from damage already registered. Reversible lethal effects have not been sought. The first part appears to be associated with the entire nucleus and predominates at high LET; the second appears to be associated with genetic material, in which the accumulation of a given number of reversible lesions leads to reproductive death; and the third appears to be associated with metabolic integrity and the ability of cells to survive the second type of injury. (146 references.) (auth)

7024 STUDIES ON THE SIGNIFICANCE AND THE ROLE OF THE SPLEEN IN THE RADIATION INJURY OF MAMMALS. H.-J. Melching (Universität, Freiburg i. B.). Acta Hepato. -Splenol., 11: 218-30(July-Aug. 1964). (In German)

The literature is reviewed and new experimental data presented relating to the importance and participation of the spleen in association with radiation damage in mammals. These findings indicate that the spleen is not only of special importance in the defense and protection of the body against the action of radiation but that the irradiated unprotected spleen, when left in place, acts unfavorably upon the whole body, in the subsequent radiation syndrome. Thus, splenectomy before and also after total-body irradiation of mammals leads to an increased survival rate. Such prophylactic splenectomy influences also the changes in tryptophan and cysteine metabolism produced by irradia-

tion. The increase of resistance after splenectomy and the resistance increase due to so-called protective substances, such as 5-hydrotryptamine or pyridoxal-5-phosphate and adenosine-5′-monophosphate are antagonistic to each other. This is possibly due to the important function of the spleen in the breakdown of thrombocytes. Biochemical studies of splenic tissue after irradiation shows a clear-cut change of the total amino acid metabolism and in particular of cysteine metabolism. These changes may result from inhibition of the decarboxylase system induced by radiation. To some degree, prophylactic treatment with radioresistance-increasing substances such as 5-hydroxytryptamine, cysteine, and pyridoxal-5-phosphate can influence the changes in cysteine metabolism caused by ionizing radiation. In general, the content of free cysteine and other sulfhydryl compounds increase progressively in spleen for five to seven days after irradiation. Appendectomy also slightly increased the survival time of whole-body lethally irradiated mice. (BBB)

7025 RADIATION, URETHANE, AND A "TRANSMISSIBLE FACTOR" IN EXPERIMENTAL LEUKAEMOGENESIS. I. Berenblum (Weizmann Inst. of Science, Rehovoth, Israel). Acta Unio Intern. Contra Cancrum, 20: 893-8(1964).

The two-stage mechanism of carcinogenesis, applied as an analytical tool for the study of leukemogenesis, led to the detection of a transmissible factor, present in x irradiated mice within 24 hours, and persisting for at least 30 days, which, while itself incapable of inducing leukemia when transferred to normal mice, rendered the recipients liable to develop the disease by subsequent urethane treatment. The possible nature of this transmissible factor is briefly discussed. (auth)

7026 SOME RESULTS OF STUDYING THE BLASTOMOGENIC EFFECT OF RADIOACTIVE ISOTOPES. N. A. Kraevskii, V. N. Streltsova, and Y. I. Moskalev (Academy of Medical Sciences, Moscow). Acta Unio Intern. Contra Cancrum, 20: 1151-4(1964).

Tumors induced in rats by deposited radioactive fission products of uranium were studied. Several types of tumors were discerned according to their mechanism of development as a function of the isotopes distribution in tissues, radiation dose, and dose rate. (auth)

7027 PROTEIN METABOLISM IN BONES DURING THE DEVELOPMENT OF THE OSTEOGENIC SARCOMAS INDUCED BY Sr^{90}. N. D. Petrova (Zivopisnaia, Moscow). and L. T. Tootochkina. Acta Unio Intern. Contra Cancrum, 20: 1155-6(1964).

Bone tissue of rats injected with ^{90}Sr was studied. Methods and results are given and discussed. Five fractions were obtained and compared for epiphyseal and diaphyseal parts of bones in control and tumor-bearing rats. (auth)

7028 BLASTOMOGENOUS EFFECT OF HIGH-ENERGY PROTONS. V. I. Fedorova and G. A. Avrunina (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Acta Unio Intern. Contra Cancrum, 20: 1164-8 (1964).

After 6 to 27 months following a single total irradiation of albino rats with high-energy protons in lethal and sublethal doses, 51 out of 92 animals under examination (55.4%) developed malignant and benign tumors (sarcomas of various localization and different histological structure, skin carcinoma, adenocarcinomas of small and large intestine, tumors of genitals, adrenals, pancreatic insulomas, leukemia, etc.). In some animals, the tumors produced extensive metastases; 15 animals were found to have primary multiple tumors. Noteworthy is the development of malignant tumors (adenocarcinomas) in the small and large intestine, which is not usually found in animals given total x and γ irradiation in doses causing equal symptoms of acute radiation lesions, as well as the appearance of malignant tumors in the genitals. The data obtained attest to the high blastomogenous effect of 660 Mev protons with the development of a broad range of tumors. (auth)

7029 PRENATAL X-RAY AND CHILDHOOD CANCER: A REVIEW. B. MacMahon and G. B. Hutchison (Harvard Univ., Boston). Acta Unio Intern. Contra Cancrum, 20: 1172-4(1964).

A study of the association between prenatal x ray and childhood cancer is described. A review of all published studies of this question revealed both positive and negative results. However, many studies were based on small numbers and the results have large sampling errors. All published studies, taken either individually or as a group, are compatible with the cancer risk in children x rayed in utero being 40% higher than in children not x rayed in utero. Several individual studies and all studies taken as a group are, on the other hand, incompatible with the hypothesis of no difference in cancer risk between the two groups. (auth)

7030 A PROSPECTIVE STUDY OF THE RELATIONSHIP OF FETAL IRRADIATION TO LEUKEMIA. E. L. Diamond and A. M. Lilienfeld (Johns Hopkins Univ., Baltimore). Acta Unio Intern. Contra Cancrum, 20: 1169-71 (1964).

Studies are currently being made on the relationship of fetal x irradiation and the subsequent development of leukemia and other malignancies in children. Exposed children (15000), born in Baltimore between 1947 and 1956 and 30,000 controls matched on race, sex, parity of mother and hospital and date of birth are being followed up during 1960-1964. The method of follow-up is listed. The final analysis will consist of comparing leukemia and other cancer death rates for exposed and control children, taking varying periods at risk into account by life-table methods. (P.C.H.)

7031 RADIOGENIC CANCER OF THE THYROID. E. W. Dorffel, N. Mangakis, and R. Vollmar (Clinique Oncologique de la Charité, Berlin). Acta Unio Intern. Contra Cancrum, 20: 1175-7(1964). (In French)

In a total material of 200 diseases of malign struma at least 19 were found where according to the anamnesis, an irradiation of the cervical region preceded due to a benign thyroid disease, a lymphadenitis, or a similar disease. The interval between irradiation of the neck and the manifestation of the malign struma lasted from 3 to 51 years, with an average of 21 years. Four of the 19 diseases of radiogenic malign struma proved histologically as sarcocarcinoma with an average interval of 39 years. At the time of irradiation 16 of the patients were already older than 20 years. The dose delivered was impossible to determine, but it is supposed that the dose was generally less than 3000 R. According to the numerous cases of benign thyroid diseases, treated by radioactive iodine, the diseases of malign struma are expected to increase in the future. (auth)

7032 A STUDY OF THE PROGENY OF MICE DESCENDED FROM X-IRRADIATED FEMALES WITH SPECIAL REFERENCE TO THE GONADS. B. K. Batra and B. N. Sridharan (Indian Cancer Research Center, Bombay). Acta Unio Intern. Contra Cancrum, 20: 1181-6(1964).

Mature female mice of the C_3H/Jlcrc and SWR/Icrc strain were irradiated with a single dose of either 300 or 400 R and thereafter kept for breeding, and four generations of the progeny were maintained and bred. Data on abnormalities showed a significant increase in the generations as compared with the controls. Regarding tumor incidence no difference was observed in both groups of the C_3H/Jlcrc strain. In the 400 R Swiss strain only leukemia increased in each succeeding generation. There was a significant decrease in litter size in the F_1 progeny of x irradiated mice. The increase in pre-weaning mortality and sterility in the generations of both strains was also significant. Except for a few males in which the testes showed impaired spermatogenesis the histology of the rest was normal. The ovarian histology of the x irradiated breeders showed tubular adenoma. In the ovaries of the progeny, proliferation, and invagination of the surface epithelium a condition normally seen in aging ovaries was present. It was significant that the ovaries of the generations showed an increase in primary or early growing follicles. The histology of the ovary represented an active gland showing early follicular growth but there was an abnormal lack of mature follicles and corpora lutea. This is consistent with the breeding history sterility and partial

sterility of the animals. It was concluded that the effect of x irradiation is a lethal one, the expression of which in the consecutive generations, being either early mortality or in adult animals sterility resulting from the lack of maturation of ova. (auth)

7033 INFLUENCES OF IRRADIATIONS ON TUMOR DEVELOPMENT AND PATHOLOGIC PROLIFERATIVE PROCESSES IN MONKEYS. L. A. Yakovleva (Inst. of Experimental Pathology and Therapy, AMS, Sukhumi, USSR). Acta Unio Intern. Contra Cancrum, 20: 1187-9(1964).

The induction of tumors or pathologic processes in rhesus monkeys by single whole-body irradiation (x and gamma rays) is presented and discussed referring to the doses, latent period, and type of growth. It was concluded from the results that the occurrence of tumors was not an immediate result of irradiation but was caused either by tissue malformation existing at the pre-exposure period (such as tumors in cystic kidneys) or by a systemic disease, endocrine disturbances in particular, which often result in tumor formation and other proliferative processes in the reproductive system of a female monkey. (P.C.H.)

7034 NEOPLASIA IN PERSONS WHO RECEIVED THYMIC IRRADIATION IN CHILDHOOD. L. S. Snegireff (Harvard School of Public Health, Boston; New England Deaconess Hospital, Boston; and Children's Cancer Research Foundation, Boston). Acta Unio Intern. Contra Cancrum, 20: 1190-3(1964).

A total of 1029 persons up to 40 years in age have been under observation for 5 years. These persons received careful medical evaluation as children, from 16 to 39 years ago in one of the large hospitals (out-patient department clinics) in Boston, Massachusetts. In the course of fluorography, 500 of these children were found to have thymic enlargement and were given thymic-irradiation. A similar thymic enlargement was found in 39 additional children and, although thymic-irradiation was proferred to them, it was refused. A comparison group of 506 persons found to have no thymic enlargement received no radiation therapy and was placed under observation for follow-up purposes. The study group of children with thymic enlargement who received irradiation, now numbers 470 persons who are alive and are being followed, while 30 have died. Of the 470, 19 developed benign adenomas of the thyroid, while 18 developed neoplasms of other anatomical sites apparently not related to thymic-irradiation. Of the 30 deceased, 2 had developed thyroid carcinomas and hence probably attributable to irradiation of the thymus. The remaining 28 died of varied unrelated causes. Discussion is presented on: the relative risk of thymic irradiation in childhood; significance of the total dose and of the individual radiation exposures; the latency period between thymic irradiation and the appearance of thyroid neoplasia; and the role of surgery in effecting a possible decrease in fatalities in groups of persons exposed to thymic-irradiation in childhood. (P.C.H.)

7035 CARCINOMA OF THE MASTOID AND PARANASAL SINUSES IN RADIUM-BEARING PATIENTS. R. J. Hasterlik (Argonne Cancer Research Hospital, Chicago and Univ. of Chicago), Ch. E. Miller, and A. J. Finkel. Acta Unio Intern. Contra Cancrum, 20: 1194-5(1964).

In a study of 300 patients bearing body burdens of radium-226 significantly above background levels, four individuals developed epidermoid carcinomata arising in the epithelium of the mastoid. Their body burdens of radium ranged from 1.4 to 4.7×10^{-6} C. Four other radium-bearing patients, two of whom had developed epidermoid carcinomata of the mastoid epithelium, one a tumor arising in the sphenoid sinus, and one a rhabdomyosarcoma of the maxillary sinus, were also studied. More recently another former radium dial painter, whose body burden of radium is 0.76×10^{-6} C, developed a squamous cell carcinoma probably arising in the antrum. (P.C.H.)

7036 QUANTITATIVE TEST OF THE INDIRECT AND DISTANT RADIOBIOLOGICAL EFFECT (ERBID) ON RAT BONE MARROW. S. Rosin (Inst. of Oncology, Bucharest). Acta Unio Intern. Contra Cancrum, 20: 1196-8(1964). (In French)

A quantitative study of the indirect distant radiobiologic effect (ERBID) was done on Wistar rats teleradiated with 716 and 1200 R, one of the posterior legs being protected with 3 mm lead. Cellularity of bone marrow withdrawn both in irradiated femur and in protected one of the same animal as well as that of normal bone marrow of non irradiated control was counted at various stages of the actinic disease. Relations of cellularity permitted precise quantitation of the ERBID and comparison of global and direct radiobiological effects in each stage. Thus, differentiated study of the radiobiological effect showed the importance of ERBID in the early stages of the actinic disease (716 R) and its discontinued evolution with two maximum stages (first and fifth days, 1200 R). (auth)

7037 RADIOSENSITIVITY OF NORMAL AND LEUKEMIC LYMPHOCYTES IN VITRO AND IN VIVO. R. Schrek (Veterans Administration Hospital, Hines, Ill.). Acta Unio Intern. Contra Cancrum, 20: 1199-1201(1964).

The slide chamber method demonstrated that large doses of x rays killed lymphocytes by delayed fixation and moderate doses killed by lobulation and intranuclear vacuolization. Lymphocytes from most patients with chronic lymphocytic leukemia had the same high degree of radiosensitivity as normal lymphocytes. A few leukemic patients, however, had blood lymphocytes that were highly resistant to x rays. The in vitro test of radiosensitivity of the lymphocytes of a patient with chronic lymphocytic leukemia may aid in predicting the behavior of that patient to therapy. Finally, it is evident that irradiation in vivo has an injurious effect on the circulating lymphocytes in the blood stream. (auth)

7038 CATALASE ACTIVITY AND RADIATION SENSITIVITY OF THE CANCER CELL. E. Magdon (Forschungsgemeinschaft, Deutsche Akademie der Wissenschaften, Berlin). Acta Unio Intern. Contra Cancrum, 20: 1205-8(1964).

The radiosensitivity of catalase was found to depend upon the oxygen content of the irradiated enzyme solution and the dose rate of the radiation used. This different radiosensitivity is caused by the hydrogen peroxide, which is produced in different amounts depending upon the oxygen content and the dose rate. The protective effect of hydrogen peroxide on the radioinduced inactivation of the catalase is caused by the formation of reversible catalase-hydrogen peroxide-complexes. It is assumed that the biological effect of the ionizing radiation is influenced by catalase, which destroys by formation of the catalase-hydrogen peroxide-complex the OH- and HO_2-radicals. In this aspect, the catalase activity ought to constitute a factor of the radiobiological sensitivity of the cell. It was found that the radiosensitivity of tumor cells is inversely proportional to their catalase activity. An increase of catalase activity involved a decrease of radiosensitivity. (auth)

7039 STUDIES ON THE X-RAY SENSITIVITY OF HUMAN TUMOR CELLS EXPOSED TO 5-BROMODEOXYURIDINE. M. A. Rich, N. Delihas, and M. L. Eidinoff (Albert Einstein Medical Center, Philadelphia and Sloan Kettering Inst. for Cancer Research, Rye, N. Y.). Acta Unio Intern. Contra Cancrum, 20: 1211-12(1964).

Exposure of H.Ep. #1 cells to 5-bromodeoxyuridine (BrUDR) under circumstances yielding a 1% incorporation of 5-bromouracil, resulted in a 1.5 to 2.0 fold increase in radiosensitivity. In an attempt to assess the increased absorption cross section for bromine to x rays as the basis for this phenomenon, the absorbed radiation energy for cells with and without incorporation of bromine was calculated. It was determined that the increase in absorbed energy due to 5-bromouracil incorporation could not account for the increased radiosensitivity. Experiments designed to determine the relationship between BrUDR induced radiosensitivity and that observed when biological materials are radiated in the presence of oxygen indicated that the two phenomena were probably unrelated. To elucidate the role of incorporation per se in the radiosensitization of mammalian cells by BrUDR, cells were exposed to BrUDR under conditions that prevented the incorporation

of the fraudulent base. These cells still exhibited increased radiosensitivity. (auth)

7040 RADIATION SENSITIVITY AND RECOVERY PATTERNS OF SPONTANEOUS AND ISOLOGOUSLY TRANSPLANTED MOUSE TUMORS. R. F. Kallman and N. duV. Tapley (Stanford Univ., Palo Alto, Calif.). Acta Unio Intern. Contra Cancrum, 20: 1216-18(1964).

The recovery of C3H mouse tumors from radiation injury was studied by estimating the injury remaining after a given conditioning dose (Dc, 1120 Rads) as a function of time until administration of a second dose. Three kinds of tumors were used: spontaneous mammary tumors (SMT) treated in situ, a spontaneous mammary tumor (ISMT) treated as isologous transplants, and an isologously transplanted hepatoma (H134). The single dose to produce 50% cures (CD_{50}), i.e., permanent regressions, of these tumors after local x irradiation were, respectively, 4230, 2730, and 2900 Rads. In the case of the SMT's the injurious effect of the Dc declined to a minimum at 2 days, then rose to a maximum at 4 days, and finally declined again to almost disappear at 6 days. The ISMT showed a less pronounced early radioresistance, while the H134 appeared to recover progressively. It is suggested that conditioning irradiation may bring about changes in tumor radiosensitivity by changing the proportions of cells in different stages of the generation cycle and therefore of different radiosensitivities. (auth)

7041 RADIATION RESPONSE OF ANOXIC C_3H MAMMARY ADENOCARCINOMA AUTOTRANSPLANTS. H. D. Suit (Univ. of Texas, Houston). Acta Unio Intern. Contra Cancrum, 20: 1226-9(1964).

The response of nineteen autotransplants of the C_3H mammary adenocarcinoma to a single dose of 2790 Rads given under conditions of local tissue anoxia is presented. The effect of this dose of radiation (250 kv) produced a delay in the growth curves of 18 autotransplants that were of the same magnitude as that observed in first generation isotransplants (C_3H mammary carcinoma). An unusual response was observed in that one autotransplanted carcinoma showed only slight changes in volume during a 180 day period of observation after irradiation. (auth)

7042 CLINICAL AND EXPERIMENTAL RESEARCHES ON THE ACTION OF LITTLE DOSES OF X-IRRADIATION ON MALIGNANT TUMORS. S. Pineles, St. Grigorescu, I. Popp, and A. Trancu (Inst. of Oncology, Bucharest). Acta Unio Intern. Contra Cancrum, 20: 1238-40(1964). (In French)

Tumor development and white blood cell count in rats and mice bearing transplantable tumors (Ehrlich, Guérin, Walker 256, 10B 9) irradiated in toto with repeated doses of 0.25–0.50–1–5–10, 15–25, and 50 R was studied experimentally. The 0.25–1 R dose accelerated the tumor development without leukocytal modification, 15–25 R inhibited tumoral growth without modification of leucocyte counts, and 50 R inhibited tumoral growth with leukopenia. At the same time, results are presented with daily local doses (10–30 R) in treatment of human tumors (more than 50 cases) especially cutaneous. The results point to the possibility of immediate cure, clinical and histological, of some malignant cutaneous tumors by means of total doses within the limit-doses of temporary epilation. (auth)

7043 STUDIES OF INDUCED MUTATIONS IN PEAS. VIII. ETHYLENEIMINE AND GAMMA-RAY TREATMENTS OF THE VARIETY WITHAM WONDER. Stig Blixt (Plant Breeding Inst., Weibullsholm, Sweden). Agr. Hort. Genet., 22: 171-83(1964).

The effects of a chemical mutagen and radiation were compared in the garden pea, Witham Wonder variety. For the ethyleneimine (EI) series the treatment was for 8 hr at room temperature at concentrations of 0.02, 0.03, and 0.05% EI, with a control series soaked in water. In the γ-ray series, the doses given were 3, 4, 5, and 6 kRad of ^{60}Co radiation at a dose rate of 6 kRad/min. After the EI treatment, correlation between mutation rate on the one hand, and concentration, growth reduction, or leaf spotting on the other, were studied on the assumption of a linear regression. When the mutation rate was measured per X_1 progeny, a significant correlation was established with concentration only. When the mutation rate was measured per X_2 plant, significant correlations were found for all of these characters. In the γ-ray series, a linear correlation with dose was found. With higher concentrations of EI a considerably higher seed yield was obtained; this higher seed yield appeared to derive mainly from nonmutated tissue. Thus the mutation rate per X_2 plant was found to be dependent on progeny size. When mutation rates were compared it was found that the highest average mutation rate after treatment with EI was 16% per X_1 progeny or 4.14% per X_2 plant. This was obtained after treatment with 0.05% EI. The highest mutation rate found in the EI series was 40% per X_1 progeny, or 6.6% per X_2 plant. This result was obtained after 0.05% EI. In the irradiated series the highest mutation rate found was 8.4% per X_1 progeny or 1.84% per X_2 plant, obtained after irradiation with 6 kRad. Thus, at its optimum concentration EI gave an average mutation rate twice that obtained with the optimum dose of radiation. The mutation spectrum was found to be significantly different when EI and γ-ray effects were compared, EI yielding about 85% chlorophyll mutations and γ rays 65% or about the same as spontaneous mutation. The increase of chlorophyll mutants after treatment with EI was found to be mainly in the chlorohom group. The nature of the spots arising on the leaves of leguminous plants after treatment with mutagenic agents is discussed. The hypothesis that they result from two-hit effects is probably not tenable, as no correlation could be found between chromosome breakage and spotting. Ethyl methane sulfonate, a very effective mutagenic agent causing a high degree of spotting and mutation, has little or no chromosome-breaking ability. Spotting after treatment with EI was clearly correlated with X_1 effects, e.g. growth reduction, and with mutation rate. (BBB)

7044 X-RAY EXPOSURE OF SWINE PREVIOUSLY EXPOSED TO A NUCLEAR DETONATION. James N. Shively (Collaborative Radiological Health Animal Research Lab., Fort Collins, Colo.), Howard L. Andrews, Albert R. Warner, Jr., Harold P. Miller, Harold J. Kurtz, and Kent T. Woodward. Am. J. Vet. Res., 25: 1128-33 (July 1964).

The 48 swine studied had been exposed four months previously to about one-half the 30-day LD_{50} of the flux of a nuclear detonation having a γ-ray-neutron dose ratio of ~ one. At the time of re-irradiation the swine were 7 months old and apparently had recovered from the primary exposure. The re-irradiation doses were 380, 480, 550, and 650 R of 3.0- to 3.5-Mev x rays from a Van de Graaff generator. Mortality data for various exposures collected 30 and 45 days after re-irradiation gave LD_{50} values of 530 and 525 R, respectively. Cumulative mortality was almost identical with that for a first irradiation. The mean weight loss was 6% of the pre-irradiation weight. Correlation between percentage of weight loss and survival time or re-irradiation dose could not be demonstrated. Weight change on the third day after re-irradiation did not allow prediction of death or survival. However, significantly more of those exposed to $> LD_{50}$ lost weight within 3 days than did those exposed to $< LD_{50}$ doses. The circulating leukocyte response of these swine during the 45 days after re-irradiation followed the usual pattern. In most swine there was a transient increase in circulating leukocytes during the 2nd week, but this did not significantly correlate with death or survival. The differential counts were consistent with those seen after primary irradiation. Relative lymphocytosis had developed in decedents at essentially the same time as in survivors. The clinical syndrome in these re-irradiated swine did not differ from that for primary-irradiated swine. The results show that even though these swine had been subjected to ½ $LD_{50/30}$ four months previously, the $LD_{50/30}$ for their 2nd exposure was not significantly different from the $LD_{50/30}$ of 486 Rad obtained on exposure of younger swine to the γ-ray-neutron flux of a nuclear detonation. Any differences between the acute response of these swine to a 2nd dose of radiation and the response after primary radiation insult were too small

to be detected by the procedures used. The relative effectiveness of the Van de Graaff x rays and the mixed radiations from the nuclear detonation have not been determined for large animals, but they seem to be nearly the same for mortality production since the average energy used for the re-irradiation compares favorably with that of the penetrating components of a detonation. (BBB)

7045 EFFECTS OF IONIZING RADIATION AND THEIR IMPORTANCE IN ANESTHESIOLOGY. John B. Little and Edward P. Radford, Jr. (Harvard School of Public Health, Boston). Anesthesiology, 25: 479-89(July-Aug. 1964).

The sources and characteristics of ionizing radiation as encountered in clinical medicine are reviewed, followed by an outline of its major local and systemic biological effects. Also, a few situations are discussed in which radiation effects may be of particular importance to the anesthesiologist. (P.C.H.)

7046 RELATIVE BIOLOGICAL EFFICIENCY OF 152-Mev PROTONS. II. DETERMINATION BY MEANS OF THE STUDY OF THE DOSE-SURVIVAL CURVE IN SALMONELLA TYPHI. P. Servant, P. Bonet-Maury, and A. Deysine (Centre National de la Recherche Scientifique, Paris). Ann. Inst. Pasteur, 106: 662-9(May 1964). (In French)

A comparative study was made of the RBE of 152-Mev protons, ^{60}Co γ rays, and 250-kev x rays on the TY2 strain of S. typhi suspended in physiologic saline. The number of surviving organisms was then determined by culturing an aliquot of the suspension on agar plates. The RBE with the three types of radiation was similar and ~ one in each case in spite of the fact that the rate of irradiation differed: 7000 rad/min for protons, 1000 to 2000 rad/min for γ rays, and 350 rad/min for x rays. However, it is possible that the RBE may be influenced to some extent by the dose rate. In each case a plot of the log number of survivors vs dose (rad) gave a linear relation. It is pointed out that these results are applicable only for the microbial system used, i.e., for simple non-budding cells. The RBE obtained here is slightly higher than that found in mammalial lethality studies. It is concluded that the linear energy transfer obtained with protons in this energy range is of the same order as that of x radiations. Comparative results with other bacterial species are discussed. (BBB)

7047 INHIBITORY ACTION OF IRRADIATED ISOLOGOUS LEUKEMIC EXTRACTS ON SPONTANEOUS LEUKEMOGENESIS ON AkR MICE. R. Latarjet (Institut Pasteur, Paris). Ann. Inst. Pasteur, 107: 1-26(July 1964). (In French)

Experiments were conducted demonstrating the inhibitory effect of irradiated virus-containing tissue extracts on the spontaneous lymphoid leukemia of AkR mice. Newborn mice were injected with an irradiated cell-free extract of isologous leukemic tissues. Litter mate controls were either not treated or treated similarly with an irradiated extract of isologous normal tissues. The injection was repeated at weekly intervals over two months. The animals were then kept under observation, and the leukemia incidence recorded. The extracts were irradiated with uv light or with x rays, the latter being used under conditions of either direct or indirect effect of radiation. The direct irradiation was conducted in oxygenated and the indirect irradiation in deoxygenated solution. If the dose of radiation was high enough to suppress the super-infection effect of the extract, but did not exceed a certain limit, the irradiated extract of leukemic tissues decreased the frequency of spontaneous leukemia. Extracts of normal tissues were ineffective. Out of five uv-irradiated extracts, one was inactive, whereas the four others decreased the incidence of leukemia by 12 to 28%. Extracts x irradiated in the absence of oxygen were more effective, decreasing the incidence by 30 to 42%. In the presence of oxygen x irradiation yielded inactive extracts. This difference between the two modes of action of x rays confirms in vivo what had been previously observed in vitro with Rous sarcoma virus. On the basis of these results a therapeutic technique is proposed whereby virus-containing tissues or tumors can be removed, irradiated, and injected into the same subject. (BBB)

7048 CONCLUSIONS OF 55 CASES OF LEUKEMIA. Alfonso Bonduel, Rita D. Kvicala, Enrique Bugnard, and Victor Ç. Badaracco (Hospital de Clinicas, Buenos Aires). Arch. Arg. Pediat., 60: 1-8(July-Aug. 1963). (In Spanish)

Analysis of the probable etiology in 55 cases of leukemia showed that prior radiation may have been involved in only one case. (BBB)

7049 QUANTITATIVE CHANGES IN BLOOD UREA IN Co^{60} GAMMA-IRRADIATED RATS. D. Zamurovic, V. Zecevic, and M. Milosevic (Univ. of Belgrade). Arhiv Farm. (Belgrade), 14: 303-7(1964).

Blood urea in rats irradiated with Cobalt-60 (600 to 1100 R) revealed no detectable changes in this parameter either immediately post-irradiation or 1, 2, 5, 15, or 30 days afterwards. (OTS)

7050 GENETIC EFFECTS OF RADIATION IN MAN. A. Leonard (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Assoc. Belge Develop. Pacifique Energie At., Bull. Inform., 9: No. 52, 23; 25-7(Oct. 1964). (In French)

Data on the genetic effects of radiation in man are briefly reviewed. The nature of the genetic effects, characteristics of the mutations, and factors affecting the appearance of mutations in the case of irradiation of the reproductive cells of the parents are considered. Irradiation to the gonads causes changes in the proportion of sexes, a higher rate of embryonic or infantile death, and the birth of malformed infants. The irradiation of embryos can cause death or the production of congenital malformations. (J.S.R.)

7051 NUCLEAR REACTIONS INDUCED BY NEUTRONS IN TISSUES OF THE HUMAN BODY. H. Schreiber and W. Peters (Versuchsund Ausbildungsstätte für Strahleuschutz, Nuremberg and Institut für Strahlenschutzforschung and der Deutschen Versuchsanstalt für Luft- und Raumfahrt, Munich). Atompraxis, 10: 485-9(Nov. 1964). (In German)

Resulting neutron radiation must be considered in the use of therapeutic radiation sources. It is shown that knowledge of the chemical composition of organic tissue is the precondition for comprehending their biological importance. It was found that a distribution pattern of the most important nuclear reactions can be established for the "first collision" tissue dose. (auth)

7052 RADIATION-INDUCED REVERSION OF TRANSITION MUTANTS. G. W. Grigg (CSIRO, North Ryde, New South Wales). Australian J. Biol. Sci., 17: 907-20(Nov. 1964).

X irradiation increased the reversion frequency of two transition mutants of Escherichia coli, one of which (meth$^-$) differed genetically from wild type by an adenine–thymine substitution of a guanine–cytosine base pair, the other (arg-2$^-$) by a guanine–cytosine substitution of an adenine–thymine base pair. The lethal effects of the radiation were greatest when protein synthesis was prevented for a period immediately after irradiation. A period of 30 min at 37°C was as effective as 22 hr. Irradiation of a saline suspension gave a lower survival of 0.2 times that of bacteria irradiated after being spread on minimal agar plates. Some induced reversion of arg-2$^-$ occurred in the absence of replication following irradiation, suggesting mutation by a non-base substitution mechanism, but the frequency of reversion increased 10-fold when semi-enriched broth agar replaced minimal-T as the selective medium. It is suggested that semi-enriched medium rescues presumptive mutants which, otherwise, are more likely to die than the non-mutant population. Unstable revertants were detected among both mutant populations. Their frequency was increased by irradiation only in the case of the meth$^-$ bacteria. (auth)

7053 TESTES INJURY AFTER WORKING IN A URANIUM MINE. W. Meyhoefer (Universität, Giessen, Ger.). Berufsdermatosen, 12: 181-93(Aug. 1964). (In German)

The case history is presented of a 53-yr-old man who, from 1951 to 1955, worked without protection in the uranium mine at Joachimstal, Czechoslovakia. During this time, atrophy of the testes occurred. Insufficient libido and infertility during marriage caused him to undergo an examination in the Dermatologic Clinic of the University

of Giessen, in 1961, where bilateral atrophy of the testes together with hypospermia of the ejaculate were diagnosed. Histologically a disorganization of the seminal epithelium and a depopulation, especially of Sertoli's cells, with fibroscleroses, hyperplasia, and adenoma of Leydig's cells were found. In the head of the normally shaped spermatozoa of normal size the concentration of nucleic acid was reduced. Uv microspectrometry showed that the nucleic acid content of the subject's sperm was only about 50% of the normal value. The sperm nuclei showed frequent degenerative changes, such as karyolysis and karyorrhexis. These findings are discussed in terms of the experience with miners at other locations, and attempts are made to estimate the dose of radiation received by such miners. However, the estimated values vary widely and the relative importance of radiation from radon and uranium salts is difficult to determine. Mention is made of earlier observations of delayed lesions in persons having performed hard labor in uranium mines during the war; hypospermia and diminished DNA content of sperm were noted in these subjects also. (BBB)

7054 INDUCTION BY RADIATION OF A NEW DIRECTION OF CHROMOSOME TRANSFER DURING CONJUGATION IN AN HFR STRAIN OF ESCHERICHIA COLI. Francoise Joset (Universite, Paris), Brooks Low, and Robert Krisch. Biochem. Biophys. Res. Commun., 17: 742-7 (Dec. 18, 1964).

Experiments that indicate that radiation treatment of the Ra1 strain of E. coli before mating induces chromosomal transfer proceeding in the opposite direction from normal Ra1 transfer are described. Radiation was carried out using x rays, uv, ^{32}P decay, and α rays (^{210}Po source). Stable Hfr invertants from irradiated Hfr Ra1 cells were isolated. Interrupted mating experiments using the invertants gave the following marker entry times: arginine 7 min, threonine 14 min, tryptophan 41 min, histidine 56 min. Preliminary results indicate that the str^s marker is transferred as a distal marker by both the Ra1 and invertant strains. This means that the origin for transfer by invertants is separated on the circular chromosome from the normal Ra1 origin, with the str^s marker located between the two. The data are consistent with the idea that irradiation prior to mating induces a fraction of the Hfr Ra1 population to transfer the bacterial chromosome in the reverse direction during mating. Two general classes of mechanism for the induction by irradiation of a new mode of transfer that appear consistent with the data are suggested. (P.C.H.)

7055 NUCLEASE-RESISTANT SEQUENCES IN ULTRAVIOLET-IRRADIATED DEOXYRIBONUCLEIC ACID. R. B. Setlow, W. L. Carrier, and F. J. Bollum (Oak Ridge National Lab., Tenn.). Biochim. Biophys. Acta, 91: 446-61(Nov. 15, 1964).

Enzymic hydrolysis of ultraviolet irradiated DNA with venom phosphodiesterase (EC 3.1.4.1) yields oligonucleotide sequences that are resistant to enzymic degradation. Most of the oligonucleotides contain thymine dimers in sequences whose general structure is pXpT$\widehat{\text{pT}}$. The number and type of the dimer-containing trinucleotides depend on the base composition of the DNA, the irradiating wave length, and the incident dose. Dimers in native DNA are eliminated by treatment of the DNA with an extract from yeast in the presence of 360-mμ light. They are eliminated very slowly from denatured DNA and not at all from trinucleotides. The splitting of dimers in trinucleotides by 240-mμ irradiation is independent of the base X in pXpT$\widehat{\text{pT}}$, but the rate of formation of dimers by 280 mμ depends on the third base. (auth)

7056 RADIOSENSITIZATION OF PNEUMOCOCCUS CELLS AND DEOXYRIBONUCLEIC ACID TO ULTRAVIOLET LIGHT AND X-RAYS BY INCORPORATED 5-BROMODEOXYURIDINE. Franklin Hutchinson (Yale Univ., New Haven). Biochim. Biophys. Acta, 91: 527-31(Nov. 15, 1964).

Evidence that 5-bromodeoxyuridine sensitizes the cells of Diplococcus pneumoniae and the transforming DNA from these cells to the same degree is presented. The most difficult part of the experiment was the incorporation of the 5-bromodeoxyuridine in pneumococcus cells. For the measurement of cell radiosensitivity, suitable aliquots were irradiated either with uv light from an unfiltered germicidal lamp, or with gamma rays from a ^{60}Co source at a dose rate of 3000 Rads/min. Cell survival was found to be an exponential function of uv dose. Cells grown in 5-bromodeoxyuridine at levels of either 10 μg/ml or at 30 μg/ml showed an increased sensitivity of 2.1–2.4 in about half of the experiments. X irradiated cells grown in 5-bromodeoxyuridine showed an increased sensitivity of only 1.2–1.4. (P.C.H.)

7057 THE RADIOSENSITIVITY OF GERM CELLS. Anita M. Mandl (Univ. of Birmingham, Eng.). Biol. Rev. Cambridge Phil. Soc., 39: 288-371(Aug. 1964).

This survey, citing 400 references to the literature, shows that, in general, mitotically active cells particularly in mammals, are highly sensitive to cell killing. In some species, inhibition of mitosis may play a considerable part in the final expression of radiation damage. However, permanent sterilization in male rodents is most readily achieved by irradiating mitotically inactive primordial germ cells before or shortly after birth. In adult males of all species, permanent sterilization only occurs if all the primary gonia are destroyed. The last pre-meiotic generation of spermatogonia appears to be more sensitive to cell-death than are earlier generations; the difference is correlated with the relative durations of the G_1, S, and G_2 periods, at least in adult mice. It is possible that mammalian premeiotic oogonia are also more sensitive than preceding generations. Interpretation of observations on insects is complicated by radiation-damage to nurse cells which may secondarily hamper the development of the germ cells. In general, sensitivity to the induction of mutations is greater in meiocytes than in gonia. Primary meiocytes are relatively insensitive to cell killing. Cells irradiated as spermatocytes may fail, or be slow to complete normal maturation division(s), or they may give rise to morphologically abnormal spermatids. The effect depends upon the phase of meiosis at irradiation. Spermatids are apparently highly resistant to the induction of morphologic abnormalities or cell death. In contrast, they are highly sensitive to the induction of dominant lethals and a variety of mutations; those at early stages of spermiogenesis appear to be more susceptible than those approaching full differentiation. Corresponding changes are less readily induced in fully differentiated spermatozoa. Anoxia during irradiation diminishes the difference between spermatids and spermatozoa, without however abolishing it. Spermatozoa irradiated after insemination are more sensitive to mutagenesis than are those retained within the testes or the male genital ducts. Irradiadiation of differentiated gametes of either sex shortly before fertilization induces a delay in subsequent cleavage. While eggs undergo some spontaneous recovery if the period between irradiation and fertilization is prolonged, spermatozoa do not. (BBB)

7058 THE EFFECT OF CHRONIC IRRADIATION UPON THE FERTILITY OF BARLEY AND WHEAT. Robert Honcariv, Ladislav Kovac, Vojtech Danko, and Olga Misutova (Univ. of Safarik, Kosice, Czechoslovakia). Biologia, 19: 573-80(1964).

The effects of irradiation by ^{60}Co on wheat and barley were investigated. A yield decrease of 50% appeared in barley after doses of 38 R/day, and in wheat after doses of 56 R/day. On the basis of the occurrence of sterile grains in a barley spike it was concluded that any damage of fertility in barley begins after the dose of 0.81 R/day and that the damage increases as an exponential function with increasing dose of irradiation. (OTS)

7059 FIELD STUDIES OF THE EFFECTS OF IONIZING RADIATION ON LICHENS. Irwin M. Brodo (Michigan State Univ., East Lansing). Bryologist, 67: 76-87(1964). (BNL-8575)

Studies of natural communities of lichens subjected to chronic gamma irradiation were carried out in the irradiated forest at Brookhaven National Laboratory. Observations were made before the start of irradiation and 9 and 22 months thereafter. A complete survey of the

lichens in one sector showed no evidence of radioinduced damage although some secondary effects apparently resulting from the radiation-caused removal of the tree canopy were seen in some Cladoniae. Photographs showed lichens to be able to persist within 6 and 8 m of the source at radiation levels of over 1000 R/day. Foliose thalli (Parmelia sulcata) between 18 and 34 m from the source (at 230-62 R/day) grew vigorously, even faster than control thalli outside the irradiated forest. The high resistance to radiation in lichens may be explained by their diffuse meristem or growth points and by the very minute nuclear volumes of the fungal and algal components. (auth)

7060 ON THE SHAPE OF X-RAY DOSE-RESPONSE CURVES FOR THE REPRODUCTIVE SURVIVAL OF MAMMALIAN CELLS. Roger J. Berry (Churchill Hospital, Oxford). Brit. J. Radiol., 37: 948-51(Dec. 1964).

In clonal cell culture experiments, not only the absolute survival to a given x- or γ-radiation dose, but also the shape of the dose-response curve for cell reproductive capacity in vitro can be altered by changes in the growth medium six days after irradiation. Comparisons are drawn between clonal survival in vitro and results obtained using transplantable tumor assays in vivo, and implications for the formulation of model systems are discussed. (auth)

7061 REGENERATION OF THE SCIATIC NERVE IN ACUTE RADIATION SICKNESS. O. N. Baishtruk and Ya. I. Ryss (Dept. of Histology and Embryology, Academy of Sciences , USSR). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 1387-9(Dec. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 100-3(Dec. 1963).

A study was made of regeneration of the sciatic nerve in 37 dogs with radiation sickness of moderate severity. Between 5 and 10 days after the sciatic nerve was sutured, regeneration lagged behind that of the control animals. Later, however, there was no difference between the two groups in the amount or rate of growth. In the irradiated animals the development of neuromas was more pronounced, and fewer nerve fibers grew out into the peripheral portion. In cases where the course of radiation sickness was more severe the changes were more marked. The intensive regenerative processes did not occur until the 15–20th day. Secondary degenerative changes of the newly-formed nerve fibers were more extensive. The delay in regeneration in the first days after division of the nerve in animals affected with radiation sickness is attributed to the direct influence of the radiation, which delays the degenerative processes and to many other reasons related to the development of the disease. (P.C.H.)

7062 LARGE VESICOVAGINAL FISTULA AFTER THE WERTHEIM OPERATION FOLLOWED BY INTRAVAGINAL RADIOTHERAPY. A. Van Bouwdijk Bastiaanse. Bull. Federation Soc. Gynecol. Obstet. Langue Franc., 13: 607-12 (1961). (In French)

After a radical abdominal hysterectomy followed by intravaginal radiotherapy, a patient exhibited one yr later a vesicovaginal fistula as large as the palm of a hand. The entire posterior wall of the bladder had disappeared, and ureteral probes passed through the vagina. The rectum was intact. Surgical repair of this radioinduced defect is described in detail. The patient was placed in the gynecologic position with very strong flexion in the hips. A bilateral episiotomy was executed and immediately a circular incision was made around the fistula. By opening the incision from the rear of the bladder, a fragment of the vaginal wall between 3 and 4 cm long was separated from the rectum. The vagina was separated from the tissue immediately beneath it on the left, right, and in front. The bladder was detached from the rectum to reach the peritoneal cavity, and the vaginal wall was separated bilaterally to the pelvic wall. By using closed, curved scissors with dull points, then the fingertips, the two sides of the pelvic wall were readily separated so the fingers could reach into the paravesical and pararectal walls. The levator muscles were sectioned on the right and left toward the rear in order not to injure the ureters. The index finger of the left hand was inserted in the rectum to avoid injury, and it was then simple to reunite the edges around the fistula. Two probes inserted in the ureters were directed outside the urethra. A first ring of catgut suture on the edges around the fistula was followed by a second suture for the levator muscles, and finally the exterior sides of the muscles were connected in the center by a third suture. Large necrotic areas were visible around the bladder and it was necessary to fill them in in order to avoid inflammation from an accumulation of secretions. The tissue used for this purpose was taken previously from a large fatty flap graft in the area of the two large levator muscles. From both sides of the bladder the fatty tissue pieces were passed into the necrotic areas to fill them in. The interior sides of the grafts were sutured with catgut to hasten union. Suture was made from the vaginal wall and from the rectum over the muscles covering the bladder. If all tension on the sutures could be avoided, then this fistula would definitely remain closed. Antibiotics (penicillin and streptomycin) were used for several days prior to and one week after the operation and both were inserted in the wounds during the operation. Although the bladder capacity was very limited at first, it is known from similar cases that this capacity will gradually increase and will eventually be almost normal. (BBB)

7063 STUDIES ON ACQUIRED RESISTANCE TO SCHISTOSOMA MANSONI IN MICE EXPOSED TO X-IRRADIATED CERCARIAE. Alina Perlowagora-Szumlewicz (National Inst. of Allergy and Infectious Diseases, Bethesda, Md.). Bull. World Health Organ., 30: 401-12(1964).

The effect of radiation on the development of cercariae within the mouse was studied. Evidence of radiation effect was sought in one group of mice by comparison of worm counts, male-female ratios, and egg counts in the liver with corresponding data obtained from control mice infected with nonirradiated cercariae; a second group was used to compare survival of mice infected with normal or irradiated cercariae. Other experiments were designed to study the effect of prior exposure to irradiated cercariae on the host's response to a challenge infection, as measured by survival, worm burden, and accumulation of eggs in the liver at various intervals after challenge. Initial infection with the irradiated cercariae did not materially alter the pattern of deaths from the challenge infection; deaths were neither prevented nor delayed. However, a lower worm burden was found in all mice after exposure to irradiated cercariae, indicating either complete suppression of migration or fast elimination of the majority of worms which reached the portal system. Although, in mice exposed to cercariae irradiated with 2500 R there were only a few worms, there were more in animals infected with cercariae irradiated with 2000 R, possibly because elimination was not so fast. Worms developing from irradiated cercariae were present continuously in most mice, as evidenced by their recovery from the portal system from 28 to 288 days after infection, but sometimes disappeared by eight months after infection. This was taken as evidence that the irradiation of cercariae decreased the longevity of the worms. Another effect of radiation was to prevent the establishment of an adult male population in a normal proportion to that of females. Evidently, the reproductive capacity of the worms was impaired, since eggs were not recovered from the liver. Irradiation with 2000 R was inadequate to impair sexual maturation of male worms. Eggs were recovered from mice exposed to irradiated male cercariae and challenged with normal female cercariae. These results show that the reduced number of worms recovered early after challenge was due merely to delay in migration of the worms. Although the presence of worms from irradiated cercariae did not interfere with the magnitude of the worm burden from challenge infection, it slightly modified the accumulation of eggs in the liver. (BBB)

7064 EFFECT OF GAMMA-RADIATION ON THE ABSORPTION SPECTRUM OF VISUAL PURPLE. N. M. Trunova. Byul. Eksperim. Biol. i Med., 58: No. 9, 72-4(Sept. 1964).

Studies were made on changes in visual purple caused by gamma irradiation of the retina of frogs in high doses (96.6 R/sec, total dose 200,000 R, 32 min 50 sec exposure). Spectrophotometric data showing decoloration of the visual

purple under these conditions is given as proof of the photochemical mechanism of the action of this radiation on the retina, but the actual way this is accomplished remains unclear. (TCO)

7065 THE ROLE OF THIOL GROUPS IN THE DEVELOPMENT OF RADIATION DAMAGE IN THYMOCYTES AND EHRLICH ASCITES CARCINOMA CELLS. J. F. Scaife (Defence Chemical, Biological, and Radiation Labs., Ottawa). Can. J. Biochem., 42: 1717-27(Dec. 1964). (DCBRL-440)

The effects of 800–1000 Rads of x irradiation on the thiol content of thymocytes and Ehrlich ascites carcinoma cells were compared. Four hours after irradiation there was a decrease in the non-protein thiol (NP.SH) content of thymus and thymocytes but no change in ascites cells. In both cells the main NP.SH compound was glutathione. There was no significant effect of irradiation on the protein thiol (P.SH) content of thymus or ascites cells, but there was a slight decrease in P.SH in thymocytes after 4 hours incubation. Isolated thymus nuclei showed an immediate small decrease in P.SH content following 800 Rads in vitro. Nuclei isolated from rat thymus 1 hour after 1000 Rads in vivo showed an increase in the SH content of the globulin fraction and a decrease in the SH content of the nucleohistones. The total SH content of thymocytes and ascites cells was reduced by slow diffusion of H_2O_2 into the cell suspension, but no effect of prior irradiation on this decrease of SH was found. Inhibition of catalase in vivo and in vitro did not produce any of the morphological signs of irradiation damage in thymocytes. There was no effect of irradiation on the copper content of thymus, thymocytes, or ascites cells. The ratio of NP.SH/P.SH was higher in thymocytes than in ascites cells, but, allowing for the difference in cell size, the overall total thiol concentration was the same. Anoxia produced only a small increase in NP.SH content in both cells and a small and doubtful increase in P.SH. It was concluded that, if thiol groups are involved in cell sensitivity to radiation, only a small fraction of the total SH groups are involved at critical sites. (auth)

7066 KARYOKINESIS OF SOMATIC NUCLEI OF NEUROSPORA CRASSA. I. THE CORRELATION BETWEEN CONIDIAL RADIOSENSITIVITY AND THEIR KARYOKINETIC STAGE. D. G. Weijer (Univ. of Alberta, Edmonton, Can.). Can. J. Genet. Cytol., 6: 383-92(Dec. 1964).

The radiosensitivity of conidia of Neurospora crassa was assessed in terms of conidial kill following irradiation at different time intervals after commencement of incubation. Filament and ring structures were observed in anaerobic as well as aerobic cultures, however their time of emergence differs greatly in the two environments. At 30°C under anaerobic conditions the filament phase occurs after 14 hours (ring phase 30 hours) whereas under aerobic conditions the filament phase appears after 90 minutes and ring phase 135 minutes. (F.S.A.)

7067 FURTHER STUDIES OF THE EFFECTS OF GAMMA RADIATION ON PORK INFECTED WITH TRICHINELLA SPIRALIS. H. C. Gibbs (MacDonald Coll., Quebec), K. F. MacQueen, and J. W. Pullin. Can. J. Public Health, 55: 191-4(May 1964).

The effect of radiation on carcasses of pork infected with larval trichinae is studied. It appears that irradiation of infected pork at 20,000 or 30,000 rad is effective in controlling the spread of trichinosis by completely suppressing the ability of the larvae to mature in a susceptible host. This suppressive effect on larval maturation does not appear to be lessened by possible shielding effects from thickness of meat, thickness of skin, bone, or fat. The results of this study indicate that irradiation offers means for controlling the spread of trichinosis from infected meat, that the irradiation of whole sides of pork is feasible, that the process could easily be developed into a routine operation, and that the estimated cost of the treatment would appear reasonable to guarantee a source of pork free from this hazard. (Public Health Eng. Abstr., 44: No. 10, Oct. 1964)

7068 CANCER RESEARCH 1964: THOUGHTS ON THE CONTRIBUTIONS OF RADIATION BIOLOGY. Arthur C. Upton (Oak Ridge National Lab., Tenn.). Cancer Res., 24: 1861-8(Dec. 1964). (ORNL-P-387)

A review is presented on the relation between radiation and cancer and the contributions of radiation biology towards understanding this relation. Discussion is presented on precautionary measures in radiation, mechanisms of radiation carcinogenesis implicated from experimental data, radiation liberation or activation of the leukemia virus, virus-host cell specificity, radioinduced neoplasms, role of somatic mutations and chromosome aberrations in the pathogenesis of radiation neoplasia, and the basis for repair of injury from ionizing radiation. 80 references are included. (P.C.H.)

7069 INTERACTION OF URETHAN AND FRACTIONATED OR REGIONAL X-RADIATION IN MICE: LUNG TUMOR AND LEUKEMIA INCIDENCE. William A. Foley and Leonard J. Cole (Univ. of Minnesota, Minneapolis and Naval Radiological Defense Lab., San Francisco). Cancer Res., 24: 1910-17(Dec. 1964).

Groups of young, adult (C57LXA)F_1 mice were treated with urethan and studied after single-dose or fractionated whole-body x radiation, or with shielding or exposure of the thorax during radiation. When a single dose (880 Rad) of whole-body x ray plus bone marrow was given 1 week or 8 weeks prior to a single dose of urethan, which produced multiple pulmonary tumors in 100% of control mice, the per cent mice with tumors and the average numbers of tumors per mouse were decreased. Fractionation (100 Rad × 9) of the radiation either before or after urethan reduced the average number of pulmonary tumors but not the percentage of mice with such tumors. Leukemia incidence, however, was increased whether urethan preceded or followed fractionated radiation. When the thorax was shielded and the rest of the body exposed no inhibition of pulmonary tumorigenesis was observed, but with thorax exposed and head and abdomen shielded both the percentage of animals with tumors and the average number of tumors per mouse were decreased. The results indicate an augmentation of leukemogenesis and an inhibition of pulmonary tumorigenesis by combinations of x ray and urethan. The inhibitory effect is directly on the lung. (auth)

7070 ACTION OF GAMMA RAYS ON THE GAMETES, ZYGOTE, AND PROEMBRYO OF THE FODDER PEA. L. M. Monti and M. Devreux (CNEN, Rome). Caryologia, 17: 433-41(May-Aug. 1964). (In Italian).

Gametes, zygote, and proembryo of the fodder pea Parvus were irradiated with 500–1000 and 1500 R of gamma rays. A histological analysis of the embryological development and the fruit set of the irradiated flowers showed that the proembryo is more radiosensitive than the gametes and zygote in all the three treatments and that 1000 and 1500 R cause a nearly total lethality. The R_0 pod fertility, the R_1 plant leaf abnormalities and fertility, and the R_2 mutation frequency after zygote irradiation with 500 R all show the greater radiobiological and genetic efficiency as compared with gametes irradiation. (auth)

7071 POLLEN FERTILITY OF NICOTIANA TABACUM L. AFTER GAMMA IRRADIATION IN THE STAGES OF GAMETES, ZYGOTE, AND PROEMBRYO. Constantin Tramvalidis and Marcel Devreux. Caryologia, 17: 453-7 (May.-Aug. 1964). (In Italian)

An analysis was made on plants of Nicotiana tabacum derived from seeds produced after gamma-ray treatment of flowers in the stages of gamete, zygote, proembryo; total doses of 1000, 2000, and 4000 R were administered in 16 hours. For zygote irradiation also total doses of 1000, 2000, and 4000 R delivered in 4 hours were used. Pollen fertility analysis of R_1 plants demonstrated that sterility increases with increasing dose. Among the irradiated stages the gametes proved to be the most sensitive, while the proembryos were the least sensitive. The two series of zygote irradiation indicated that high dose rates induce lower pollen sterility than lower ones. (auth)

7072 BLOOD AND SKIN CHROMOSOMAL ALTERATIONS OF A CLONAL TYPE IN A LEUKEMIC MAN PREVIOUSLY IRRADIATED FOR A LUNG CARCINOMA. E. Engel, J. M. Flexner, Mireille, L. Engel-de Montmollin,

and Helen E. Frank (Vanderbilt Univ., Nashville). Cytogenetics, 3: 228-51(1964).

A case is reported in which chronic myelogenous leukemia was diagnosed in a man three years after irradiation for surgically removed bronchogenic carcinoma. The Philadelphia chromosome was found in blood metaphases. Chromosome alterations were present in four parallel cultures of a skin biopsy taken from the site of previous irradiation. All 122 karyotyped metaphases were abnormal although their mode was diploid or near diploid or in the range of 4n for the relatively frequent polyploid cells. In this material marker chromosomes permitted the sorting of cells within five stemlines. One of the marker chromosomes in skin metaphases had the features of the Philadelphia chromosome, showing satellites and acrocentric association, although it may have arisen from any of the ten satellite acrocentric chromosomes. As a rule, studies of x-ray induced damages to blood cells in non-leukemic man have not indicated clonal perpetuation of chromosome anomalies. This case suggests that clonal evolution may have been part of regenerative processes stemming from radiation-modified survivor cells in solid tissue. (auth)

7073 THEORETICAL STUDIES ON THE METHODOLOGICAL PROCEDURES OF RADIATION BREEDING. II. EXPECTATION OF THE NUMBER OF DESIRABLE MUTANTS WITH THE NEW METHODS. Yoshio Yoshida (Kyushu Agricultural Experiment Station, Fukuoka). Euphytica, 13: 65-74(1964).

If the expectation of the number of desirable mutants for equal size of X_2-populations decreases with decreasing number of plants per X_2-line, the one-plant-one-grain method (method C), the one-plant-two-grain method (method D), and the one-plant-three-grain method (method E), especially method C, would be disadvantageous in comparison with the improved ear-to-row method (method B) and the conventional ear-to-row method (method A). From theoretical considerations it is shown that a probability of occurrence of an X_2-line containing desirable mutant (p_1) and a conditional probability of occurrence of such desirable mutant for each one of the plants in such an X_2-line (p_2) are not affected by the number of X_2-lines (m), but by the number of plants per X_2-line (n). Consequently, the expectation of the number of desirable mutants in an X_2-population, E(I), can be given by $E(I) = m\, p_1 (1 - q_2^n) \cdot n\, p_2/(1 - q_2^n) = mn\, p_1 p_2$ where $p_1 + q_1 = 1$ and $p_2 + q_2 = 1$. Therefore, with respect to E(I), method A = B = C = D = E for equal size of X_2-populations. However, method A ≫ B ≫ E > D > C for different sizes of X_2-populations. (auth)

7074 RADIATION-INDUCED CHROMOSOMAL REARRANGEMENT IN ANNUAL CHRYSANTHEMUM. R. S. Rana (Indian Agricultural Research Inst., New Delhi). Experientia, 20: 617(1964).

The consequences of radioinduced chromosomal rearrangements on reproductive potential of Chrysanthemum carinatum were studied. Dry seeds were subjected to an acute x-ray dose of 15 kr at an opening voltage of 50 kv and an initial population of 200 plants was raised. Low fertility and retarded growth rates were observed. (M.C.G.)

7075 ANTIMITOTIC EFFECTS OF CHLORAMPHENICOL AND OTHER INHIBITORY AGENTS IN CHLAMYDOMONAS. B. S. Jacobson, R. J. Salmon, and L. L. Lansky (Univ. of Minnesota, Minneapolis). Exptl. Cell Res., 36: 1-13(Oct. 1964).

Three Chlamydomonas species with division cycles characterized by the occurrence of 2 to 4 mitoses per cycle, were subjected to chemical or physical antimitotic agents incorporated into or applied to agar on which predominantly single cells were spread. In several cases, the sensitive stages in the cell cycle were determined from the distributions of microcolony sizes at the cessation of cell division. Two species showed a highly specific response to chloramphenicol similar to the response to lethal x-ray doses. The first mitosis of a cycle was sensitive to chloramphenicol, while the second mitosis was resistant. This is inferred from the observation that nearly all colonies were arrested in the 1-, 4-, or 8-cell stage. Most cells went through one complete cycle after plating on chloramphenicol or after irradiation; one-half of the cells did so after a combined treatment. Assays of macromolecular components of chloramphenicol-inhibited cells were consistent with the hypothesis that chloramphenicol acts as an inhibitor of protein synthesis. The pattern of 1-, 4-, and 8-celled colonies formed in the presence of chloramphenicol or after x irradiation could not be duplicated by the response to ultraviolet irradiation, β-mercaptoethanol, 5-fluorouracil, or darkness. (P.C.H.)

7076 EFFECT OF STORAGE OF X-RAY IRRADIATED ONIONS ALLIUM CEPA L. ON CHANGES IN CELL PERMEABILITY. V. Srb (Charles Univ., Hradec Kralove, Czechoslovakia). Exptl. Cell Res., 36: 270-4(Nov. 1964).

Plasmolytic experiments during storage for four months of x irradiated onions Allium cepa L. showed that cell permeability is changed with time. The longer the storage of x irradiated (1000 ± 40 R) onions the slower the onset of complete plasmolysis in them. An explanation of this phenomenon is based on the fact that the decrease in water is slower in irradiated onions during storage owing to both natural and postirradiation changes. (auth)

7077 THE EFFECTS OF X-RADIATION ON THE CHROMATIN STRUCTURE AND HISTONE COMPONENTS OF RAT THYMOCYTE NUCLEI. J. F. Whitfield, H. Brohee, and T. Youdale (C.C.R.-EURATOM, Ispra, Italy). Exptl. Cell Res., 36: 341-53(Nov. 1964).

Irradiation caused the condensed, reticular chromatin structures of the nuclei of rat thymocytes to disaggregate and the nuclei to become structurally homogeneous. This was accompanied by the appearance of histones in the cytoplasm while the histones that remained in the nucleus could no longer be stained with fast green although they could be stained by the Sakaguchi reaction (which stains protein-bound arginine). The development of these changes was prevented or strongly retarded by increasing the NaCl concentration of the medium after irradiation. It was also retarded by the addition of spermidine to the cultures immediately after irradiation. It is suggested that these procedures owed their effectiveness to their ability to cause chromatin condensation. The rate of appearance of radioinduced nuclear changes was strongly influenced by the inorganic phosphate concentration of the medium. It is proposed that chromatin disaggregation is primarily caused by an increase in the inorganic phosphate concentration in the nucleus since phosphate is known to competitively remove the chromatin-condensing histones from their salt-like linkages with DNA. High salt concentrations would retard the radiation effects by condensing the chromatin and thus rendering it less accessible to the phosphate and they might assist a damaged sodium-dependent transportation of metabolic intermediates into the nucleus. Spermidine can react with phosphate and thereby reduce the effective intranuclear phosphate concentration as well as rendering the chromatin less accessible to phosphate attack by aggregation. (auth)

7078 CHANGES IN NUCLEAR HISTONE OF IRRADIATED RAT THYMOCYTES. J. F. Whitfield, H. Brohee, and T. Youdale (C.C.R.-EURATOM, Ispra, Italy). Exptl. Cell. Res., 36: 417-21(Nov. 1964).

The use of histone-specific alkaline fast green and ammoniacal silver techniques revealed three types of histone in the nuclei of normal thymocytes; DNA-bound, nucleolar, and diffusely distributed histones. The nucleolar and diffusely distributed histones were readily extractable with hot trichloroačetic acid (TCA) while the DNA-bound histone was not. Irradiation caused the DNA-bound histone to become evenly dispersed throughout the nucleus and to become extractable with hot TCA. Some of the nuclear histone of irradiated cells escaped into the cytoplasm where it became bound and resistant to TCA extraction. (auth)

7079 RAT FEEDING STUDIES ON WHEAT TREATED WITH GAMMA-RADIATION. I. REPRODUCTION. J. R. Hickman, D. L. A. McLean, and F. J. Ley (United Kingdom Atomic Energy Authority, Wantage, Berks, Eng.). Food Cosmetics Toxicol., 2: 15-21(1964).

Three groups of 30 male and 30 female rats in 4 successive generations were fed a diet containing 75% wheat that

was either untreated or irradiated at a dose of 20 or 200 kRad. The reproductive performance and the growth and health of the progeny were studied in all generations when the animals were mated at 12-13 weeks old. In one generation the rats were mated on three occasions (at 12, 23, and 52 weeks). The inclusion of irradiated wheat in the diet of rats had no apparent effect on their fertility, on the size of litters produced, nor on the growth of the offspring. On the basis of criteria used, it was concluded that wheat irradiated for disinfestation purposes is safe for comsumption. (auth)

7080 RAT FEEDING STUDIES ON WHEAT TREATED WITH GAMMA-RADIATION. II. GROWTH AND SURVIVAL. J. R. Hickman, T. Greenwood, J. O. Bull, and F. J. Ley (United Kingdom Atomic Energy Authority, Wantage, Berks, Eng.). Food Cosmetics Toxicol., 2: 175-80(1964).

Wheat treated with 20 or 200 kRad of gamma radiation was fed to rats as 75% of the diet. Studies on body weight and survival measured over 4 generations revealed no significant difference between the effects of diets containing irradiated or non-irradiated wheat. Food consumption and utilization were unimpaired. No toxicity was detected by organ growth rate measurements, although in a single instance with the 20 kRad irradiated wheat, splenic enlargement was observed. (auth)

7081 QUANTITATIVE ANALYSIS OF THE EFFECT OF X-RADIATION ON YOSHIDA SARCOMA CELL. Yahiro Irako. Gann, 55: 141-54(Apr. 1964).

The effect of x radiation on tumor cells was studied with respect to the kind of cytologic changes induced by radiation and the resultant effect on malignant growth. Rats, intraperitoneally transplanted with 10^7 Yoshida sarcoma cells, were irradiated with either a 200 or 1000 R dose of x rays over the whole body, 72 hr after transplantation. The ascitic fluid of these animals was examined for the total number of tumor cells and cytologic changes. Increase in numbers of Yoshida sarcoma cells was inhibited for more than 48 hr by a dose of 1000 R and for ~24 hr by 200 R. The mitotic time as well as intermitotic time of the tumor cells was prolonged by irradiation. Abnormal mitotic figures of the tumor cells increased after irradiation, presenting two peaks, a first and second maxima. The first maximum occurred one hr after irradiation in mitotic cells, and six hr afterwards in interphase cells. The second maximum occurred 24 or 48 hr after irradiation in mitotic and interphase cells. The most conspicuous morphologic changes of tumor cells caused by the radiation were the fragmentation and aberration of chromosomes in mitotic cells as well as fragmented nuclei in interphase cells. Some of the irradiated tumor cells showed necrotic changes. The radiation injury of tumor cells in postmitosis was more intensive than that in the premitotic period. (BBB)

7082 EFFECTS OF RADIATION ON LITTER SIZE IN SWINE. D. F. Cox (Iowa State Univ., Ames). Genetics, 50: 1025-8(Nov. 1964).

A total of 382 Duroc and 418 Hampshire litters arranged in sets of double first cousins were used for an analysis of the effects of paternal irradiation on litter size at birth. One male from each pair of brothers used in the mating plan was exposed to 300 R x irradiation 5 to 6 months before the matings were made. Litters from x-rayed Duroc males were 0.6 pigs larger than litters from their control brothers. Litters from x-rayed Hampshire males were 0.5 pigs smaller than litters from their control brothers. In each breed, the treatment group that had the highest initial litter size showed the higher percentage of mortality between birth and 42 days. (auth)

7083 DOMINANT EFFECTS ON PRODUCTIVITY IN OFFSPRING OF IRRADIATED MOUSE POPULATIONS. K. G. Luening and William Sheridan (Stockholm Univ.). Genetics, 50: 1043-52(Nov. 1964).

The dominant effects of irradiation administered to the males of each generation of a mouse population were studied in comparison with a parallel control. An irradiation dose of 276 R of x rays to spermatogonia was used. The productivity, measured in litter size at weaning, was studied for the populations and their offspring in each generation. The occurrence of dominant subviability effects has been studied in intensely mated F_1 males of the population and, in a separate experiment, in which F_1 sons of males irradiated with 550 R of x rays were compared with controls. Dominant effects of recessive lethals were studied in offspring of families adjudged to be lethal bearing. It was concluded that the major dominant effects of irradiation were to be found in the direct offspring to the irradiated animals. There was no evidence of an accumulation of dominant detrimental effects in successive generations. Dominant subviability effects in F_1 males were extremely rare. No evidence was found to support the view that recessive lethals have dominant deleterious effects. (auth)

7084 GENETIC EFFECTS OF CUMULATIVE IRRADIATION ON PRENATAL AND EARLY POSTNATAL SURVIVAL IN THE RAT. A. B. Chapman, Janet L. Hansen, G. B. Havenstein, and N. E. Morton (Univ. of Wisconsin, Madison). Genetics, 50: 1029-42(Nov. 1964).

Experimental procedures, methods of statistical analyses, and results of the first four generations of an experiment to estimate the genetic effects induced by x irradiation in the laboratory rat are presented. The traits used to reflect these effects are sex ratio, number of live births per litter, and postnatal survival. No clear evidence of genetic effects of this cumulative irradiation is available from the results in the first four generations of irradiation. One estimate which is suggestive of an effect is based on the sex ratio data in the line in which male ancestors received 450 R of x irradiation each generation. In this case, it is estimated that the rate of induction of sex-linked recessive lethals per R is $(2.14 \pm 1.5) \times 10^{-4}$. This estimate is not inconsistent with those made in humans and mice. Two estimates of the rate of induction of sex-linked recessive lethals per R in man are 2.2×10^{-4} and 4.2×10^{-4}. An estimate of the rate of induction per R for sex-linked recessive lethals in mice is 1.25×10^{-4}. The estimates of rate of induction of lethals made in the present experiment are based on the assumption that these mutations are completely recessive, fully lethal when homozygous or hemizygous, that epistasis does not play a role in their expressions, and that chance homozygosis is negligible. The effect on the estimates of rate of induction if these assumptions are not correct is discussed. On the basis of estimates of sex-linked mutation rate in humans and mice, it is predicted that at least nine generations of x irradiation with the dosage used here will be needed for a trait such as sex ratio to provide sufficient power to the tests to detect a mutation effect. The experiment will be continued to at least this stage of development. (auth)

7085 EMBRYONIC MORTALITY IN MOUSE POPULATIONS AFTER ELEVEN GENERATIONS OF SPERMATOGONIAL IRRADIATION. Earl L. Green, Thomas H. Roderick, and Gunther Schlager (Jackson Lab., Bar Harbor, Me.). Genetics, 50: 1053-63(Nov. 1964).

Males of six populations of inbred mice and of six populations of hybrid mice were mated with their sisters and with females of an unrelated inbred strain. The six populations in each group represent three levels of spermatogonial x irradiation and two levels of inbreeding. Spermatogonia were exposed to 0, 50, or 100 R of x rays in each generation, and the inbreeding coefficient was varied but controlled within limits by fixing the number of mated pairs per generation as either 8 or 16. The populations were propagated for 11 generations with random mating excluding brother-sister matings. The females, both sister and unrelated, were killed at about 15 days of pregnancy and the numbers of corpora lutea, moles, dead fetuses, and living fetuses counted to see if any differences in embryonic mortality attributable to radiation exposure, inbreeding level, or both had developed between the populations. The mice in the litters from the brother-sister matings each received two irradiated or control genomes, whereas the mice in the litters from the outcrosses received only one irradiated or control genome. No differences between the populations related to radiation or inbreeding experience were apparent in rates of embryonic losses prior to implantation, immediately after implantation, or long after

implantation. The total number of females dissected was 902; the average number was 37.6 per set. (auth)

7086 LEARNING ABILITY AND PHYSICAL WELL-BEING IN OFFSPRING FROM RAT POPULATIONS IRRADIATED OVER MANY GENERATIONS. Howard B. Newcombe and John F. McGregor (Atomic Energy of Canada Ltd., Chalk River, Ont.). Genetics, 50: 1065-81(Nov. 1964).

Rats descended from male animals x irradiated over as many as 12 generations showed reduced maze-learning ability. The combined results from all experiments, involving totals of 463 animals from irradiated and 461 from control populations, indicate a decline in maze performance which would be comparable on a percentile basis to a decline in mean I.Q. for humans of 5.35 points, e.g., from 100 down to 94.65. There was a 70 percent increase in dull and a 30 percent decrease in bright animals (groups representing the bottom and top 15 percent of the population, comparable on a percentile basis to humans with I.Q.'s of 85 and below, and of 115 and above, respectively). The accumulated exposures to ancestors of these animals, when averaged over all animals tested from the irradiated groups, amounted to 2587 Rads. There are reasons for believing that this effect may be greater, to an unknown extent, than that of similar accumulated exposures in man. The animals were mated immediately after exposure, a procedure which permitted inheritance of broken and rearranged chromosomes that would not have been transmitted had the matings been substantially delayed. A radiation-induced reduction in litter size may have had adverse effects on offspring from the irradiated groups, an effect which would have no analogy in humans. Differences in other, nonbehavioral, traits of rats from irradiated and control populations are described. (auth)

7087 SELECTION FOR EGG NUMBER WITH X-RAY-INDUCED-VARIATION. H. Abplanalp, Dorothy C. Lowry, I. M. Lerner, and E. R. Dempster (Univ. of California, Berkeley). Genetics, 50: 1083-1100(Nov. 1964).

An attempt was made to exploit x-ray-induced mutations in subsequent selection for high egg number in chicken populations. X radiation of 1000 to 1500 R per generation was administered to chicken sperm over a period of seven generations for a total of 8000 R. Following this irradiation phase the populations so treated were selected for high egg number along with controls. To date six generations of selection have been completed. The results suggest that genetic damage during the irradiation phase was pronounced for hatchability (embryo viability), egg production, and other traits associated with reproduction, while average egg size was relatively unchanged. Selection following the radiation phase restored hatchability and egg production to levels only slightly below controls within two generations, suggesting that dominant deleterious genes were eliminated at that stage. Response to selection for egg number in subsequent generations was no different or perhaps a little less in irradiated lines than in controls. It must thus be concluded that 8000 R of irradiation was not sufficient to induce substantial amounts of genetic variation accessible to selection for high egg production. Inbreeding results from brother x sister matings in the last generation of selection have indicated that the irradiated populations carry a larger load of recessive deleterious genes than controls. Their effects may be almost unnoticed in the noninbred selected populations but are exposed when made homozygous by inbreeding. (auth)

7088 EFFECTS OF CONTINUOUS LOW INTENSITY RADIATION ON SUCCESSIVE GENERATIONS OF THE ALBINO RAT. Sidney O. Brown (Texas Agricultural and Mechanical Univ., College Station). Genetics, 50: 1101-13 (Nov. 1964).

Gamma irradiation during the entire prenatal life of rats delivered at 50 R per 20 hour day (1000 R total dose) was not incompatible with production of living offspring. The progeny, however, exhibited a limited number of anomalies such as reduction in body weight, microencephaly and a reduction of weight of certain organs, i.e., liver, spleen, and kidney. Irradiation at rates of 2, 5, 10, and 20 R per day to mature females was shown to be ineffective in preventing reproduction at least through four successive litters in the albino rat. However, offspring receiving 10 and 20 R daily throughout prenatal and postnatal life were sterile. The male rat was shown to be much more sensitive than the female rat with regard to radiation-induced sterility. In albino mice irradiated continuously from prenatal through various postnatal periods, the female proved to be the most susceptible when sterility was considered. Exposure of albino rats from the 15th day of gestation through the 23rd day of postnatal life to rates of 1, 2, 5, 10, 20, and 40 R resulted in dose-dependent damage to the testes. Dose rates of 10, 20, and 40 R per day (total doses of 300, 600, and 1200 R) were found to produce permanent sterility in the males. Exposures of 2 R per day given continuously for 11 generations appear to have had a cumulative hereditary effect resulting in reduced litter size. (auth)

7089 LIFE SPANS OF MICE AS AFFECTED BY CONTINUING IRRADIATION FROM COBALT-60 ACCUMULATED ANCESTRALLY AND UNDER DIRECT IRRADIATION. John W. Gowen and Janice Stadler (Iowa State Univ., Ames). Genetics, 50: 1115-42(Nov. 1964).

Ten strains of mice, four pairs for each strain were initially exposed from mating to death to ^{60}Co γ irradiations for 22 hours per day. Each successive generation from the initial pairs was maintained in the irradiation field from conception to death. Five of the ten strains failed to survive beyond the fifth generation. The other five strains, Bab, BaB, E, S, and N have now gone beyond the 12th and one has reached the 24th generation in the continuing irradiation. When these analyses were made, these five strains had completed lives through the sixth generation. The frequency distributions of life span with generation or within strain, are all unimodal. They differ from normal distributions in both significant constants, Beta 1 and Beta 2. Strains differed in their mean life durations throughout the six generations of continuing irradiation, the amount of variation encompassed being 38 percent. Some shortening of the duration of life occurred with continued generations of irradiation exposure. For three strains, the decline was curvilinear asymptoting to a constant value for each strain. Over-all strain effects were the major contributors to differences in life span, followed by generation effects. The interaction between strain and generation showed that not all strains reacted similarly to the generations of continuing irradiation. Correlating ancestral irradiation dosages, within positions of the mice in the radiation field, with the life spans showed small average values of either sign. The largest value was −0.085 which would account for less than 8/1000 of the variation. On this basis, the ancestral irradiations over the six generations had little effect on the life spans of the mice. The theory that ancestral irradiations, received at rates within the animal's physiological ability to repair, lead to cumulative detrimental mutations in future progenies is heavily discounted by this evidence. For rate of irradiation occurring directly to the embryo from conception to birth, or from birth to weaning, the average correlations of dose rates with life spans were small, −0.06 and −0.006, and statistically insignificant. Correlations of rate dosages under 500 R for 38 days after weaning with life span were likewise small, −0.06, accounting for about 4/1000 of the variation. They were only of borderline statistical significance. However, the correlations of rate dosages, averaging above 1100 R in the weaning to 38 days postweaning period, were distinctly higher, averaging −0.27. They accounted for about 73/1000 of the variation in duration of life, and the effects were in the highly significant range. The point of break-over of the continuing irradiation affects the late adolescent stage of life. It occurs with irradiation rates between 500 and 1100 R. A threshold change in the radiation effects is expressed. The increased severity of the irradiation effect furnishes another instance of a change in the system of receptors for the radiant energy. The severity of the effects of continuing low-rate irradiations accumulated to the same or larger total dosages and compared with higher-rate acute dosages was shown to be noticeably less. The comparisons were made on the same physiological traits

and strains, the radiation being generated by the same machines and laboratory conditions. (auth)

7090 GENETIC EFFECTS OF CHRONIC IRRADIATION GIVEN TO MICE THROUGH THREE SUCCESSIVE GENERATIONS. Tsutomu Sugahara (Kyoto Univ.). Genetics, 50: 1143-58(Nov. 1964).

Three series of experiments designed to obtain rates of certain classes of mutations for a whole gamete of the mouse, and to search for mutations detectable only by statistical means on the same mouse, are summarized. In two experiments three successive generations were irradiated with chronic γ radiation in order to accumulate recessive mutations. Autosomal recessive lethals, detected by means of Haldane's method, changes in litter size, sex ratio, and percent juvenile death were studied in their offspring. In another experiment, adult male mice were irradiated with acute x radiation and chronic γ radiation for one generation. The scheme of breeding and irradiation was taken from Haldane (1956). A consistent result was obtained from Haldane's method. The result indicated a mutation rate to recessive lethals of $4.3 \times 4.8 \times 10^{-3}$ per autosomes per R and the existence of a dose-rate effect. Results on other items were rather inconsistent except for juvenile death, but suggested complicated genetic effects of radiations on mammalian populations. Further study will be required to elucidate the nature of genetic effects detectable only by statistical means. (auth)

7091 EFFECTS OF LOW-LEVEL IRRADIATION ON FITNESS AND SKELETAL VARIATION IN AN INBRED MOUSE STRAIN. A. G. Searle (Medical Research Council, Harwell, Berks, Eng.). Genetics, 50: 1159-78(Nov. 1964).

Sublines of the highly inbred strain C3H/HeH were kept in a ^{60}Co γ radiation field for many generations, receiving 1 R per night and about 80 R per generation. Data pertaining to fitness were analyzed for the first 24 generations. Litter size in irradiated sublines was only slightly below controls with respect to first and second litters, but from the third to the sixth litters it fell progressively in irradiated sublines, with an associated early onset of sterility. These findings were attributed to the extreme sensitivity to killing of young dictyate oocytes leading to significant depletion of stocks even at the low dose rate of 0.001 to 0.0015 R/min. The incidence of complete sterility was not increased in irradiated lines, however. Embryonic survival to 14 days was significantly decreased in both sib- and nonsib-matings derived from irradiated sublines, when compared with controls; the extra load of recessive lethal mutations induced by the irradiation of all germ-cell stages was estimated to be 1.8×10^{-4}/gamete on a per-roentgen basis. The incidence of dominant lethal mutations was about 2.7 percent, presumably induced mainly in post meiotic germ-cell stages, while 4.0 percent excess embryonic lethality was attributed to heritable sublethal factors, which were probably mainly heterozygous effects of recessive mutations. The irradiated sublines did better than the control sublines with respect to some mainly maternal traits. Thus there were significantly fewer losses of whole litters in the irradiated series as far as litters 1 to 3 were concerned, in which litter sizes in the two series were comparable. Postnatal mortality before weaning age was reduced to almost half control values in the irradiated series, the effect showing up in both early and later litters. These findings raise the possibility that some mutations in the irradiated series were to alleles conferring postnatal heterozygous advantage on this highly inbred background, but other explanations cannot at present be excluded. Skeletal variation with respect to 23 quasi-continuous and four metrical characters was studied in descendants of two pairs of sublines. For both types of variation the rate of divergence of the two control sublines was higher than the rate for the two irradiated sublines. The main divergence seemed to have taken place in one of the control sublines, the probable explanation being that a major polygenic mutation, or residual heterozygosis, had become fixed in this subline and had thereby altered the frequencies of a number of variants simultaneously, leading to a spuriously high differentiation rate. Further work will be needed to investigate this hypothesis and derive the true rate of divergence, so that the rate of induction of polygenic mutations can be calculated. (auth)

7092 SOME EFFECTS OF X IRRADIATION IN SUCCESSIVE GENERATIONS ON AN INBRED AND A HYBRID POPULATION OF MICE. B. W. Touchberry and F. A. Verley (Univ. of Illinois, Urbana). Genetics, 50: 1187-1209(Nov. 1964).

Males of a hybrid ($B6D2F_1/J$) and an inbred (C57BL/6J) strain of mice were subjected to levels of 0, 50, 100, 150, and 200 R of x irradiation. Females of the same two strains were subjected to levels of 0, 10, 20, 30, and 40 R. Males and females of the same strain were mated in all combinations with respect to x-ray treatment resulting in a 5×5 factorial experiment. One hundred pairs of hybrid mice and 200 pairs of inbred mice were used initially; thus there were four and eight pairs of mice per subclass initially for hybrids and inbreds. Four pairs of progeny from the second litters from each subclass were chosen at random and treated just as their parents were treated to produce the subsequent generation for both hybrids and inbreds. Data on six generations of the hybrid population or 1042 litters were available for this study while data on only four generations or 570 litters of the inbred population were available. The inbred and hybrid females differed greatly in their response to irradiation. Levels of 30 and 40 R essentially sterilized the inbred females as measured by the ability to produce second litters while these same levels had little effect on the hybrid females. For number per litter, weight at a given age, and growth rates, the inbreds and hybrids responded quite similarly. For each increase of 50 R given the hybrid male parent, number at birth decreased 0.47 mice per litter, weight at 32 days increased 0.23 g per mouse, and growth from 2 to 38 days increased 0.0058 g per mouse per day. The comparable values for each increase of 50 R given the inbred male parent were 0.34, 0.19, and 0.0031 respectively. For each increase of 10 R given the hybrid female parent, number at birth decreased 0.27 mice per litter, weight at 32 days increased 0.20 g per mouse, and growth from 2 to 38 days increased 0.0053 g per mouse per day. The comparable figures for inbred females were 0.35, 0.25, and 0.0077. The values for both inbred and hybrid female parents include both genetic and somatic effects while the values for male parents should be genetic effects only. In general, irradiating the inbred female parent results in greater response than irradiating the hybrid female parent. On the other hand, it seems that irradiating the hybrid male parent has produced a greater response than irradiating the inbred male parent. The decrease in number per litter is evidence of dominant lethal mutations, while the increases in average weight and growth rates in the surviving progeny are evidence of heterotic effects of mutations other than dominant lethals. (auth)

7093 GENETICAL STUDIES ON HEADING IN RICE PLANTS. I. CHARACTERISTICS OF SOME MUTANT STRAINS ON HEADING TIME INDUCED BY X-RAY OR β-RAY. T. Matsuo (Tokyo Univ.) and T. Nakajima. Ikushugaku Zasshi, 10: 137-42(1960). (In Japanese)

For the purpose of genetic studies on heading characters in rice plants, 14 mutant strains on heading, which were induced from 5 varieties by x or β rays, were collected and their characteristics on heading photoperiodic sensibility and minimum heading duration were investigated. Generally speaking, the earliness or lateness on heading time of the mutant strains compared with the original variety were mainly attributed to the decreasing or increasing of the photoperiodic sensibility, and were slightly connected with the minimum heading duration too. For further particulars, M_1 strain from Norin-No. 8 was 10 days earlier than the original variety under natural conditions but was 7 days later under the high temperature and short day conditions. So, in this strain, the photoperiodic sensibility decreased, but the minimum heading duration increased. The mutant strains that were very early and viridis type, i. e. M_3 strain from Norin-No. 8, M_3 strain of Chusei-Aikoku, and M_1 strain of Norin-No. 29 were turned into the non-sensible strain on the photoperiodic response on

heading time. With some strains, changes of the morphological and physiological characters, i.e., length of the culm, number of panicles, stiffness of the straw, and fertility were observed. (P.C.H.)

7094 EFFECT OF DIFFERENT OXYGEN PRESSURES ON THE RADIATION AFFECT. N. G. Nor-Arevyan and S. P. Semerdzhyan. Izv. Akad. Nauk Arm. SSR, Biol. Nauki, 17: No. 4, 25-31(1964). (In Russian)

Studies showed that high pressure of O and N up to 50 atm does not affect the growth of Vicia faba and Pisum sativum sprouts of 2-3 days old. Experiments conducted with x irradiation showed that with an increase of O pressure from 0 to 30 atm, the effect of 90 R on V. faba sprouts increased, and then decreased with further increase of pressure up to 50 atm. The effects of 150-200 R on P. sativum sprouts increased, reaching the maximum value at 1-3 atm. At 4 atm an increase of plant resistance occurred, which remained unchangeable with further increase of pressure up to 50 atm. Variation of O pressure (lowering or raising to definite values) inhibited the effects of radiation on the sprouts. (P.C.H.)

7095 ANALYSIS OF THE ANAPHYLACTOGENETIC AND REACTOGENETIC PROPERTIES OF SYNTHETIC AND HETEROGENEOUS ALBUMIN PLASMA SUBSTITUTES IN ACUTE RADIATION SICKNESS. U. R. Karavaeu. Izv. Akad. Nauk Belorussk. SSR, No. 4, 91-102(1962). (In Russian)

Studies showed that repeated injections of heterogeneous plasma substitutes intensified the post-transfusion reaction in moderately acute radiation sickness in guinea pigs. Intensification of anaphylaxis was based on the presence of antibodies in the serum of the radiation- guinea pigs to the albumin. (P.C.H.)

7096 THE FREQUENCY OF RADIATION INJURIES OF CHROMOSOMES IN RADICLE OF WHEAT SEED. P. K. Shkvarnikov and A. M. Livensi (Inst. of Cytology and Genetics, Novosibirsk SSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser., Biol.-Med. Nauk, No. 4, 28-34(1963). (In Russian)

Significant differences in the frequency of radiation-induced chromosome aberrations in radicles from a single wheat seed were shown in 97% of the seeds studied. The differences are explained by changes in the physiological state of the cells during germination. Thus the mutagenic effect of radiation is dependent on the state of the cells in the seed. Data are presented which show that in studies of seed mutation, the results must be corrected to a common basis. Chromosome aberrations in the first mitosis should be compared for one definite radicle. (tr-auth)

7097 FUNDAMENTALS OF AGING: IMMOBILIZATION OF PROTEINS IN WHOLE-BODY IRRADIATED WHITE RATS. Johan Bjorksten, Fred Andrews, Julia Bailey, and Bruce Trenk (Bjorksten Research Foundation, Madison, Wis.). J. Am. Geriat. Soc., 8: 37-47(Jan. 1960).

Whole-body x irradiation was used to accelerate the onset of senescence in female white rats. Comparisons of non-irradiated and irradiated tissues were made using histologic, physical, and enzyme techniques. Conditions of irradiation were established under which rats receiving a total of 1890 R showed a minimum of specific adverse effects. The data amassed to date indicate that x irradiation causes a reduction of 20.6% in the amount of alpha-amino nitrogen liberated by tryptic hydrolysis in liver homogenates. Determinations of collagen shrinkage temperature in irradiated rat-tail tendons indicated that irradiation results in cross-linking of proteins in a manner resembling that observed in non-irradiated mature tendons. Apparently irradiation also severed peptide bonds in the collagen, which complicated interpretation of the data. It is postulated that these observations may be useful both for a study of collagen structure and also as a clinical method for determining the amount of irradiation absorbed accidentally. (auth)

7098 THE CELL CYCLE OF BLAST CELLS INVOLVED IN SECONDARY ANTIBODY RESPONSE. Toshihiko Sado and T. Makinodan (Oak Ridge National Lab., Tenn.). J. Immunol., 93: 696-700(Oct. 1964). (TID-21401)

The role of blast cells (hemocytoblasts, plasmablasts, and lymphoblasts) in the antibody response was studied in rabbits immunized with bovine serum albumin. Spleen suspensions, containing these cells, were introduced in chambers into the peritoneal cavity of x-irradiated (660 R) mice. Spleen cells from primed donors were cultured with the test antigen in diffusion chambers. The cell cycle of blast cells was analyzed during the latent-log phase transition when the number of these cells remains constant. The estimated length of time for the various phases was: G_2, 0.7 hr; M, 0.5 hr; G_1, 0 to 1 hr; S, 5 to 6.8 hr; and the GT, 8 to 9 hr. No significant difference between the experimental and control groups was observed. The data on mean grain number per metaphase cell as a function of time after a single pulse exposure of these cells to ^{3}H-thymidine showed that the peak level occurred 3 to 4 hr after labeling, which corresponds to the latter third of the S phase. (BBB)

7099 THE RELATION OF RADIATION DOSAGE TO ENHANCEMENT, DEPRESSION, AND RECOVERY OF THE INITIAL FORSSMAN HEMOLYSIN RESPONSE IN RABBITS. William H. Taliaferro and Lucy G. Taliaferro (Argonne National Lab., Ill. and Univ. of Chicago). J. Infect. Diseases, 114: 285-303(Oct. 1964).

A total of 72 series of rabbits were given a single whole-body x irradiation within a range of 25 to 700 R and a single intravenous injection of $10^{8.3}$ sheep red blood cells from 2 days before to 2 months after radiation. A control series consisted of nonirradiated rabbits. Antigen given within 2 days before the various doses of x rays resulted in a significant enhancement of titer. When antigen was given within the same length of time after irradiation, enhancement was replaced by a marked depression of titer. Recovery occurred thereafter. Enhancement was of 2 types. Type 1 was characterized by a stimulation of the immune process, i.e., by a normal or above normal rate of hemolysin production operating during a normal length of time, and type 2 was characterized by a retardation of the immune process, i.e., by a subnormal rate of production continued over a long time. (P.C.H.)

7100 5-HYDROXYINDOLYL COMPOUNDS IN THE RAT BRAIN AFTER X-IRRADIATION. D. Palaic, Z. Deanovic, and Z. Supek (Inst. "Ruder Boskovic," Zagreb). J. Neurochem., 11: 761-3(Oct. 1964).

Previous work showed an increase of the total 5-hydroxytryptamine (5-HT) content of the brains of rats and mice after whole-body x irradiation. Since the physiological action of 5-HT is produced by its free form, postirradiation changes of this 5-HT fraction were sought by determination of 5-hydroxyindoleacetic acid (5-HIAA), the main metabolite of 5-HT. This serves as an indirect method of estimation of free 5-HT. Therefore, the influence of x rays on the concentration of 5-HT and of 5-HIAA in different parts of the rat brain was studied by estimation of the total, acidic, and basic 5-hydroxyindolyl compounds. Acidic 5-hydroxyindoles correspond mainly to the 5-HIAA and the basic ones to 5-HT. Rats were exposed to 220-kv x rays at a dose rate of 83 R/min, and immediately after irradiation the animals were sacrificed and assays made in hemispheres, cerebellum, and brain stem (medulla oblongata, pons, mesencephalon, and diencephalon). A significant increase of the total 5-hydroxyindoles was observed in the whole brain immediately after 900 R of x rays. This increase was mainly due to the increase of these compounds in the brain stem. Since the basic and acidic components in brain were not increased, it is likely that this increase was due to the neutral compounds. The concentration of acidic and basic 5-hydroxyindoles was unchanged in the brain stem. The sum of acidic and basic 5-hydroxyindoles in the controls corresponded to total 5-hydroxyindolyl compounds, but this did not hold true for irradiated animals. There were no postirradiation changes in the blood concentration of total 5-hydroxyindolyl compounds. (BBB)

7101 A REVIEW OF THE ACUTE RADIATION SYNDROME IN DOMESTIC ANIMALS. J. H. Wilkins. J. Roy. Army Vet Corps, 29p.(1962/63).

A review is presented on radiation effects on domestic

animals, such as pigs, cattle, sheep, goats, dogs, and burros. Lethal studies, clinical signs, and pathological aspects are discussed. Data are tabulated. 118 references are included. (P.C.H.)

7102 SWELLING OF LIVER CELLS AFTER EXPOSURE TO IONIZING RADIATION. F. Y. Yang, J. H. Lin, and S. K. Lee. K'o Hsueh T'ung Pao, No. 9, 814-16(1964). (In Chinese)

The swelling of rat's liver after exposure to x radiation was investigated by means of the Lehninger method. Doses of 20,000, 40,000, and 70,000 R were used in the individual experiments. The results showed that the swelling is reduced with increasing doses; however, addition of certain natural organic resin acids to the specimens caused the swelling to increase with increasing dose. It was concluded that exposure to ionizing radiation accelerates the aging effects in liver cells. (TTT)

7103 ON RADIATION INJURY OF THE CRYSTALLINE LENS THROUGH WORKING WITH LUMINOUS DIALS. Carola Loescher (Universität Augenklinik, Heidelberg). Klin. Monatsbl. Augenheilk., 142: 743-7(1963). (In German)

A 56-yr-old patient was employed to paint luminous watch dials for over 25 yr. For this work she used a loupe placed before the right eye. The distance between her face and the radioactive material was 10 cm. She applied the material with a pencil until 1951, and with a foot operated sprayer since that time. Measurements showed that her clothes, body, and apartment were contaminated with radioactivity. She was examined medically, radiologically, and dermatologically, but there was no evidence of any radioinduced lesion. An opthalmalogical examination showed bilaterally clear bulbi. However, there were bilateral axial opacities of the posterior lens cortex in the region of the posterior pole. They were arranged conically, and were interspersed with several vacuolated areas, and mica-like iridescent regions. This type of opacity is similar to the very early stages of radiation cataract. In patients close to 50 yr of age it is difficult to differentiate between presenile, metabolic, or exogenously produced cataracts. In this patient, although visual acuity was not impaired by the opacity found, a radiation lesion of the lens was assumed because of the patient's long working association with Ra paint. This was in recognition of the observation that dial painters employed uninterruptedly for five yr or more are exposed to enough dosage from the Ra to cause a lenticular eye lesion. (BBB)

7104 EFFECTS OF MEDIUM-HARD AND HARD X RAYS ON PISUM SATIVUM L. WITH SPECIAL REFERENCE TO PRE-TREATMENT WITH LEAD-CONTAINING SOLUTIONS. Charlotte Vogel. Kulturpflanze, 11: 295-332(1963). (In German)

The growth of pea seedlings was inhibited by the influence of hard x rays (800 r and more). However a sudden growth stop did not happen even in the application of higher doses. The zone most sensitive to radiation was within the root meristem. Radiation experiments (15 to 20 kr) yielded serious damages in pea seeds. The effect was the same in seeds treated with lead salts and in untreated seeds. Soaked seeds were more sensitive than dry ones. Experiments in the green house and in the field proved that a dose of 4 kr inhibits germination and plant development, higher doses also cause an inhibition of root development. Sensitization by preparation with lead salts was not proved. Differences in the effects of hard and medium-hard radiation were not observed distinctly. (auth)

7105 STUDIES ON THE BIOLOGICAL EFFECTS OF THE FACTOR INDUCING LEUKOCYTOSIS AFTER X-RAY IRRADIATION. Tomotada Owan. Kumamoto Igakkai Zasshi, 37: 38-55(1963). (In Japanese)

The upper abdomen of rabbits was irradiated with 140 kv x rays to a total dose of 200 R at the rate of 25 R/min. Blood was drawn after 3 to 3.5 hr, and a leukocytosis-inducing agent (referred to as NPR) was separated from the plasma according to the Ogata method (Nippon Hoshasen Igaku Zasshi, 21: 372(1961)), and subjected to various biological tests. Toxicity of NPR in the mouse was low and the lethality rate was 0/5 with doses up to 10 mg/10 g body wt. A notable increase of peripheral leukocytes in rabbits was observed after NPR injection, reaching a peak within three hr. Oxygen consumption by leukocytes, liver, and pancreas showed an increase after NPR injection. Rabbit liver, pancreas, and bone marrow showed an increase in enzyme activity (including dehydrogenases) after NPR injection, especially in the bone marrow. It is concluded that the NPR injection which brings about an increase of metabolic activity of the white blood cell itself also stimulates the marrow's release or production of leukocytes. (BBB)

7106 LEUKEMOGENIC EFFECT OF IONIZING-IRRADIATION TREATMENT IN POLYCYTHEMIA. Baruch Modan and Abraham M. Lilienfeld (Johns Hopkins Univ., Baltimore). Lancet, 2: 439-41(Aug. 29, 1964).

This study was undertaken to estimate the risk of acute leukemia among patients with polycythemia vera and to determine whether the risk was increased as a result of ^{32}P and/or x-ray treatment. This was done by following patients with various types of polycythemia and different forms of treatment, who had originally been seen at seven hospitals in Maryland, New York, Massachusetts, and Oregon. The mortality of these patients with regard to leukemia and related myeloproliferative disorders was analyzed, using hospital, necropsy, and local physicians' records and death certificates. The survivorship status of 1202 patients was determined and the numbers and proportions of patients in whom acute leukemia developed in the various diagnostic treatment groups evaluated. Thus, 11% of the polycythemia vera ^{32}P-treated group, 8.9% of the x-ray treated group, and 16.7% of those who had received combined treatment had died of acute leukemia, compared to less than 1% in the control patients who had not been subjected to treatment with ionizing radiation. These differences are significant at the $P = 0.001$ level. These findings support the hypothesis that ^{32}P plays a major role in the development of acute leukemia in polycythemia vera patients, and are consistent with other recent observations on the leukemogenic effect of ionizing radiation. The dosage effect of ^{32}P on the subsequent development of leukemia was tested by comparing the risk of death from acute leukemia with increasing doses of ^{32}P. Patients who had received both ^{32}P and x-ray treatments were omitted from the analysis because the x-ray and ^{32}P effects could be cumulative. An increasing risk of acute leukemia with increasing dose of ^{32}P was demonstrated. For example, the incidence of leukemia averaged 3.8% in patients receiving 5 to 9 mC of ^{32}P compared with 28.6% in those receiving 60 mC or more. An improved survival of the ^{32}P-treated patients could have contributed to the observed dose-response relation because it is conceivable that patients who had been followed for longer had received higher doses of treatment. However, an attempt to answer this problem by computing the proportion of acute leukemia cases by dose and time after first treatment shows that the proportion of leukemia is on the whole higher in the higher dose groups in each two-year period after diagnosis. This implies that the length of survival is not a major factor in the development of acute leukemia. Certain variables that might have, indirectly, influenced the finding of a higher frequency of acute leukemia among the ^{32}P-treated group than among those not radiation-treated were also analyzed. Age, sex, length of survival, initial hematocrit level, white blood cell count, or presence of splenomegaly, as well as differences in the period of diagnosis or hospital population groups, were not found to be related to the higher frequency of acute leukemia among the radiation-treated patients. (BBB)

7107 LEUKAEMOGENIC EFFECT OF IONISING-IRRADIATION TREATMENT IN POLYCYTHAEMIA. Edwin E. Osgood (Univ. of Oregon, Portland). Lancet, 2: 967(Oct. 31, 1964).

Comments are made on the report of Modan and Lilienfeld (Lancet, 2: 439(Aug. 29, 1964)) showing that radiotherapy of polycythemia increases the incidence of leukemia. It is pointed out that this report failed to recognize the fact that such treatment also prolongs life in polycythemia more effectively than any other method of treatment. They fail to indicate that only 123 of the 228 patients

(54%) treated exclusively with ^{32}P were dead, which gives a mean survival time of 13.2 yr after diagnosis. The mean age at diagnosis of this group was 55.4 yr, giving a mean age at death of 68.6 yr. Of the 133 patients with polycythemia treated by methods other than radiation, 94 (71%) were dead; and the predicted survival of these 133 patients is 8.4 yr. Their age at diagnosis was 56.6 yr, giving a mean age at death of 65 yr. Of the total number of deaths in the combined polycythemia and questionable-polycythemia group, the 57 who developed acute leukemia had lived a mean of 11.2 yr; the 297 patients treated with radiation who had not developed acute leukemia had lived 8.2 yr. The 270 cases treated by methods other than radiation had lived a mean of 4.7 yr. It is pointed out that Modan and Lilienfeld also fail to emphasize what is clearly evident in their data, namely, that the frequency of acute leukemia decreases rather than increases with time at risk after radiation therapy is instituted, and that the apparent increase with dose is related to the fact that dose increases with survival time. It is suggested that most persons would rather run some risk of dying of leukemia at an advanced age than of dying younger without leukemia; moreover, that all human activity carries some risk, and it is necessary to weigh the benefits against the risks. (BBB)

7108 COMBINED X-RAY-RADAR TREATMENT: OBSERVATIONS ON THE SURVIVAL OF PANIRRADIATED GUINEA PIGS. Edmondo Balestra and Ennio Pignataro (Università, Genoa). Minerva Med., 53: 1357-8(May 2, 1962). (In Italian)

The physical changes that x irradiation causes in experimental animals are augmented if exposure to radar follows. Forty guinea pigs were submitted to whole-body (800-R skin doses) of 200-kv x irradiation. Twenty of these animals were then exposed to radar eight times a day for 15 min at a time. The number of deaths in the control (x-ray) and experimental (x-ray + radar) animals were as follows: after 10 days, 0, 5; 11 days 4, 6; 12 days 4, 3; 14 days 6, 4. At 15 days 4 controls still survived while all experimental animals were dead. In a second group exposed to 400 R skin doses of x rays, 18 of the 20 controls were alive up to the 20th day, two animals dying on the 15th and 16th days. In contrast, in the guinea pigs treated with 400 R and radar, all had died by the 16th day. These results demonstrate the potentiating effect of radar on the lethal action of ionizing radiation. (BBB)

7109 MALFORMATIONS OF THE SKELETON DUE TO IRRADIATION DURING PREGNANCY. P. Guidi and G. Pinelli (Università, Genoa). Minerva Ortoped., 13: 794-9(Dec. 1962). (In Italian)

The injurious effects of in utero irradiation of children on osteogenesis are reviewed and two new cases are presented in which defective bone development followed maternal irradiation in early pregnancy. The effects of radiation in causing skeleton malformations in the fetus vary in relation to the intensity of radiation and to the distant or direct exposure of genital organs. One case is cited of skeletal and cutaneous abnormalities in a baby born to a woman irradiated for a tumor of the mediastinum. Also observed was a case of spina bifida in a baby because of the intense x irradiation of the mother's spinal glioma. In another case, a boy did not show any deformities at birth but, when he reached 11 years of age, his somatic and psychic development were retarded; his mother at about the time of conception was being treated for liver sarcoma with a radiation dose of 3600 R. However, apparently all investigators on the basis of available clinical observations do not agree on the harmful effects of distant or indirect irradiation. For example, the case of a pregnant woman treated for carcinoma of the breast (2500 R) whose infant showed no sign of injury is cited. The conclusion is reached that there may be definite injuries done to the fetus only when high doses of radiation are used in proximity to the gravid uterus but that there should not be any damage if low doses are applied (variously estimated at 25 to 200 R). In the first weeks of pregnancy high doses of radiation may produce miscarriage (in 29 out of the 34 cases cited), the sensitivity of the fetus to radiation decreasing progressively from 100% expected injury in the first two months to 64% and 23% in the 3rd to 4th and 6th months. The syndrome designated as roentgen microcephalia is normally rare with an incidence of 1/10,000, but it has a 25% occurrence in babies of irradiated mothers; whereas a 5% rate of malformations of the extremities is noted compared to 0.14% in unirradiated infants. The conclusion is reached that large doses of radiation are definitely teratogenic and that small doses given in therapeutic and diagnostic treatment may augment and may favor the appearance of spontaneously occurring fetal malformations. (BBB)

7110 THE IMMEDIATE CELLULAR RADIOBIOLOGICAL EFFECT. L. Campi and M. Randaccio (Università, Turin). Minerva Radiol. Fisioterap. Radiobiol., 9: 388-95 (Sept. 1964). (In Italian)

The germinal cells of guinea pigs were investigated with the aid of electron and optical microscopy immediately after and three hours after irradiation with 1000 Rads. The immediate histological changes, consisting in changes of the cell membrane only, are described. The findings were compared with those of others and the pathogenesis of the changes observed are discussed. (auth)

7111 EXPERIMENTAL RESEARCH ON THE LEUKOPENIC EFFECT OF CYCLOPHOSPHAMIDE ASSOCIATED WITH WHOLE-BODY IRRADIATION. I. M. Stoppa, C. Martinenghi, and G. Agati (Università, Turin and Università, Milan). Minerva Radiol. Fisioterap. Radiobiol., 9: 395-400(Sept. 1964). (In Italian)

An experimental investigation was made of the leukopenic effect of ionizing radiation and cyclophosphamide, and both treatments in conjunction with each other. The augmentation of the leukopenic effect of each treatment alone and the combination (especially with regard to the time factor) causing the greatest leukopenic effect was determined. Tests were carried out in adult rats with high doses of both the chemotherapeutic agent (100 mg/kg) and the radiation (500 R whole-body irradiation). A constant enhancement of the leukopenic effect was noted, irrespective of the type of association. The maximum effect was obtained when irradiation preceded the administration of cyclophosphamide. (auth)

7112 FIRST RESULTS ON CHANGES AFTER WHOLE-BODY IRRADIATION ON SERUM CREATINEPHOSPHOKINASE. G. Sanna (Ospedale Civile, Cesena, Italy). Minerva Radiol. Fisioterap. Radiobiol., 9: 400-4(Sept. 1964). (In Italian)

The serum creatine phosphokinase activity (a specific muscular enzyme) was determined in rabbits exposed to whole-body irradiation of 800 R. Controls carried out up to 10 days after irradiation showed a very marked increase of the activity of this enzyme, with values considerably greater than normal. It is suggested that the increase is associated with the necrotic phenomena caused by radiation and with the metabolic muscular disorder that occurs after exposure to x rays, as demonstrated by the changes simultaneously observed in the creatine and ATP levels. (auth)

7113 HISTOLOGICAL AND HISTOCHEMICAL FINDINGS IN PLACENTA OF RATS SUBJECTED TO IRRADIATION. I. M. Stoppa, G. Agati, G. Sinistrero, V. Aimone, and P. F. Carazzone (Università, Turin and Ospedale Ostetrico-Ginecologico S. Anna, Italy). Minerva Radiol. Fisioterap. Radiobiol., 9: 404-8(Sept. 1964). (In Italian)

The effects produced by irradiation on the placenta of rats were studied. After emphasizing the considerable weight loss in irradiated placenta (about 40%), it is shown on the basis of histological and histochemical research that the three layers constituting normal placenta (labyrinthine, trophoblastic, and giant cells), the labyrinthine layer, and the giant cells are especially damaged. The damage from radiation is characterized by phenomena of coagulative necrosis and, from a histochemical point of view, by thickening of the DNA and RNA, which lose their normal granular structure. (auth)

7114 THE DISTRIBUTION OF X-RAY INDUCED MUTATIONS TO CHROMOSOMAL STRANDS IN PARAMECIUM AURELIA. R. F. Kimball (Oak Ridge National Lab., Tenn.). Mutation Res., 1: 129-38(1964).

Most of the mutations induced by x irradiation in G_1 of

Paramecium aurelia were found in all the progeny produced by cell division, showing that the two conserved pre-existing strands and the two new ones formed at the subsequent chromosome duplication are all affected. There were a few cases in which only one pre-existing strand and the corresponding new one were affected. There was no evidence for induced mutations affecting only the new strands. The data show that reparable premutational damage is probably a localized lesion involving both pre-existing strands and that the lesion is converted to irreparable form at the time of duplication. The bearing of these findings on the interpretation of the molecular mechanisms of x-ray mutagenesis is discussed. (auth)

7115 PHOTOREVERSAL AND "DARK REPAIR" OF MUTATIONS TO PROTOTROPHY INDUCED BY ULTRAVIOLET LIGHT IN PHOTOREACTIVABLE AND NON-PHOTOREACTIVABLE STRAINS OF ESCHERICHIA COLI. Evelyn M. Witkin (State Univ. of New York, Brooklyn). Mutation Res., 1: 22-36(May 1964).

A photoreactivable variant (strain H/r30-R), obtained from a radiation-resistant, argenine-requiring derivative (strain H/r30) of Harm's non-photoreactivable (phr^-) mutant of Escherichia coli B, was compared with its parent strain. The photoreversibility of uv-induced mutations to prototrophy was found to be about the same in the two strains. Since the phr^- strain lacks the ability to split thymine dimers produced by uv in its DNA, but photoreverses these mutations to the same extent as does the phr^+ strain, it was concluded that the uv lesions leading to prototrophy are not thymine dimers. In experiments varying the time of exposure to photoreversing light, it was found that the efficiency of photoreversal of uv-induced prototrophy was considerably greater in the phr^+ strain than in the phr^- strain. This was interpreted as evidence that the photoreversal of preprototrophic damage is hindered by the presence of thymine dimers in the DNA. The efficiency of photoreversal of these mutations was also found to decrease with increasing uv dose in the phr^- strain, lending further support to the conclusion that photoreversal of uv-induced prototrophy becomes less efficient as the number of thymine dimers in the DNA increases. In an experiment involving three successive exposures to uv, each followed by an incubation to allow dark repair of prototrophy induced by the preceding dose installment, the rate of dark repair was also found to decrease as thymine dimers accumulated in the DNA. These findings were interpreted as evidence that the uv damage leading to prototrophy is produced directly in DNA, and not in low-molecular-weight precursors of nucleic acid synthesis. Several mechanisms whereby thymine dimers might affect the efficiency of repair of other uv lesions in the DNA are proposed. (P.C.H.)

7116 STUDIES OF IRRADIATED MOUSE POPULATIONS. III. ACCUMULATION OF RECESSIVE LETHALS. K. G. Luening (Radiation Genetics Lab., Stockholm). Mutation Res., 1: 86-98(May 1964).

In a mouse population the males of each generation were given 276 R x rays to spermatogonia. Another population was kept as control. Offspring from the 3rd and up to and including the 7th generation were mated either by brother × sister or non-brother × sister crosses. The former shows both dominant and recessive effects, the latter dominants only. The prenatal death rate before and after implantation was recorded as well as litter size at birth in some tests. The results indicated that recessive lethals are induced at a low rate detectable only after accumulation over several generations. Estimates based upon the number of fetuses alive, or litter size at birth, were more uncertain than those on prenatal survival. Comparisons with lethal rates in spermatogonia in Drosophila indicate that in mice 2-4 times as many lethals as in the genome of Drosophila are induced per genome. It is stressed that the hazards should be discussed in relation to mutation rate per genome rather than per locus. (auth)

7117 GENETIC EFFECTS OF SPERMATOGONIAL X-IRRADIATION ON PRODUCTIVITY OF F_1 FEMALE MICE. A. G. Searle (Medical Research Council, Harwell, Berks, Eng.). Mutation Res., 1: 99-108(May 1964).

Hybrid male mice were given two doses of 600 R high intensity x rays eight weeks apart and outcrossed 12 weeks after the second dose. Daughters were also outcrossed and effects on their productivity studied by obtaining data from their first 4 litters at birth and from their fifth at about the 14-day fetal stage. Controls had exactly the same treatment apart from the irradiation. The average number of liveborn per tested female fell by 4.8% from 26.0 in the controls to 24.7 in the irradiated series. The mean litter-size fell significantly by 5.5%. The main factor reducing productivity was inherited semi-sterility in 6.7% of daughters of irradiated males, with none in controls. When combined with data on sons of the same irradiated males this gave an estimated rate of induction of translocations in spermatogonia of 6.4×10^{-5}/genome/R after two doses of 600 R. This rate is about one-sixth that reported for spermatozoal irradiation at similar single doses. It is suggested that this difference is mainly due to differential radiosensitivity of spermatogonial mitotic stages, with only the most condensed stages having a similar sensitivity to that of spermatozoa. The sex-ratio at birth fell significantly from 52.0% in the progeny of control daughters to 49.4% in the irradiated series. Other data, however, gave little evidence for the action of recessive sex-linked lethals, or the presence of XO mice. It was concluded that the sex-ratio decrease was probably due mainly to other unknown causes. (P.C.H.)

7118 HAEMATOPOIETIC STEM CELLS. J. P. Lewis and F. E. Trobaugh, Jr. (Presbyterian-St. Luke's Hospital, Chicago and Univ. of Illinois Coll. of Medicine, Chicago). Nature, 204: 589-90(Nov. 7, 1964).

Using a bioassay developed for the transplantation potential of marrow, observations were made on hematopoietic repopulating cells. It is shown that they undergo renewal and differentiation, thus indicating that they are stem cells. Small numbers of hematopoietic cells were transplanted into heavily irradiated isologous hosts. It was found that a rather constant proportion of the injected colony-forming cells seed in the spleen and proliferate rapidly with a doubling time of 10 to 14 hr. It was also found that, following transplantation, repopulating cells first are directed to produce differentiated hemic elements, and later begin to replenish their own population. It was concluded that hematopoietic stem cells are pluripotential and are directed at the time of seeding to differentiate along one cell line and that daughter stem cells produced in parallel with differentiated hemic cells retain their pluripotential capacity for differentiation. (M.C.G.)

7119 RELATIONSHIP BETWEEN NUCLEAR VOLUME AND RADIOSENSITIVITY OF DIFFERENT CELL TYPES IN GEMMAE OF MARCHANTIA POLYMORPHA L. M. W. Miller and A. H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Nature, 204: 596-7(Nov. 7, 1964). (BNL-8444)

The radiosensitivity of cells in Marchantia polymorpha L. can be examined by noting the position of the vegetative outgrowths produced by the gemmae. Some of the gemmae were exposed in plastic containers to various amounts of ^{60}Co gamma rays and all gemmae were allowed to grow aseptically for two weeks on inorganic agar medium. The average nuclear volume of the apical cells was 98.9 ± 4.9 μ^3; the average nuclear volume of the non-apical vegetative cells was 54.7 ± 3.3 μ^3. The 0% survival exposure was 29 kr for apical cells and 55 kr for vegetative cells. It was apparent that those cells with larger nuclei are more sensitive to radiation. (M.C.G.)

7120 RECOVERY FROM SUB-LETHAL X-RAY DAMAGE OF MAMMALIAN CELLS DURING INHIBITION OF SYNTHESIS OF DEOXYRIBONUCLEIC ACID. J. H. Kim, M. L. Eidinoff, and J. S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). Nature, 204: 598-9(Nov. 7, 1964).

Experiments were carried out to determine if the recovery phenomenon from x-ray damage to bacterial and mammalian cells requires uninterrupted DNA synthesis during the interval between fractionated doses. In these experiments 5-fluorodeoxyuridine (FUDR) was used as an inhibitor of DNA synthesis. It was demonstrated that the mecha-

nism of repair process does not require uninterrupted DNA synthesis. Cells exposed to FUDR appeared to be slightly more radiosensitive. A dependence of the recovery curve on the metabolic state of the cell was suggested by the results. (M.C.G.)

7121 SCHISTOSOMA MANSONI: HUMORAL TRANSFER OF PROTECTIVE FACTORS PRODUCED BY IRRADIATED CERCARIAE. Alina Perlowagora-Szumlewicz (National Inst. of Allergy and Infectious Diseases, Bethesda, Md.). Nature, 204: 1009-10(Dec. 5, 1964).

The way in which exposure of mice to irradiated cercariae of Schistosoma mansoni affects the course of the challenge infection was studied. Mice were exposed on three occasions to 500 mixed cercariae irradiated with 2000 R. The infected mice were bled 60 and 90 days after the last exposure and the sera used in immunization tests. Evidence of humoral immunity transferred to fresh animals was sought in worm counts, in liver-egg counts, and mortalities. It was found that the protective factors produced by the irradiated cercariae were more potent or at a higher titre 3 months after exposure than after 2 months. The number of worm pairs in the portal system of mice that received immune serum prior to infection was also lower than those from control mice, and these counts did not rise as the infection became older. (M.C.G.)

7122 POSTIRRADIATION LEUKEMIA IN CBA MICE. M. Laznicka, J. Libansky, and M. Svoboda (Inst. of Hematology and Blood Transfusion, Prague). Neoplasma, 11: 385-8(1964).

Forty CBA mice (6 to 12 weeks of age, both males and females) received four single doses of 150 R at three day intervals to give a total whole-body x irradiation dose of 600 R. After irradiation the animals were followed 10 months, those that died within two months from irradiation being excluded from the evaluation. Of the 40 irradiated animals, 21 survived for a period of two months after irradiation. Of this group of 21 mice, 6 (28.2%) appeared to develop leukemia at 5, 7, 9, 9, 10, and 10 months. Macroscopically, these leukemias were manifested mainly in neoplastic thymus enlargement, hepato- and splenomegaly, or in the enlargement of lymph nodes, especially of abdominal ones, and at times also in external axillary lymph nodes. Their cytologic features, in the liver and spleen, included numerous elements containing nuclei of lymphoid character, mostly devoid of nucleoli. In some cells nuclear chromatin was arranged in the form of coarser granules. Present also were bare nuclei, stripped of their cytoplasm, and at sites the so-called Gumprecht shadows, usually typical also of human lymphatic leukemia. By its cytologic features the leukemia was defined as being of lymphatic type. In the irradiated mice hepatomas were also seen, but this finding, in view of spontaneous occurrence of hepatomas in this strain, cannot be interpreted as being due solely to ionizing radiation. (BBB)

7123 RADIATION STERILIZATION OF MEDICAL SUPPLIES. Shosaku Kinoshita, Norio Kato, Masahiro Kinoshita, Keiko Hattori, and Tsuyoshi Sunada (Div. of Sanitary Engineering, Radiation Center, Osaka Prefecture). Nippon Eiseigaku Zasshi, 18: 371-8(Dec. 1963). (In Japanese)

Medical supplies such as absorbent cotton, paper cotton, gauze, sticking plaster, and sutural silk thread artificially contaminated by E. coli, Staphyl. aureus, B. subtilis, Mycobact. tubercul., and Clostridium histol. were irradiated by γ rays of ^{60}Co for the purpose of sterilization. They were completely sterilized by a dose of 2×10^6 Rad, and their essential qualities as medical supplies were not damaged. However, above 1×10^7 Rad, their qualities were damaged and they became no longer suitable for practical use. (auth)

7124 ON THE OCCURRENCE OF HALF-CHROMATID BREAK-REUNION IN MEIOSIS. Hajime Matsuura, Shigeyuki Tanifuji, Masaki Iwabuchi, and Hajime Kanazawa (Hokkaido Univ., Sapporo). Nippon Idengaku Zasshi, 37: 348-56(1962). (In Japanese)

At first ana-telophase and second ana-telophase in the pollen mother cells (PMC's) of Trillium kamtschaticum which were irradiated with 20 to 120 R doses of x rays at various stages from diplotene to first metaphase, the diagnostic configurations of half-chromatid recombination, viz., 2-side-arm bridges, were frequently observed. As far as the PMC's irradiated at stages from mid-prophase to first metaphase are concerned, the earlier the meiotic stage of the cells, the lower is the frequency of 2-side-arm bridges resulted. Almost all of 2-side-arm bridges are presumably brought about from exchange or union between two non-sister half-chromatids of two associated chromatids, the possibility of which is suggested from spatial relation of the four chromatid threads in a bivalent at late prophase and first metaphase. These findings, indicating that the occurrence of 2-side-arm bridges is frequent regardless of the number and position of interstitial chiasmata, may be explained on the basis of Matsuura's Neo-two plane theory, that is, free two-by-two disjunction of the four sister kinetochores of a bivalent at anaphase after free opening-out of the chromatids at diplotene. (BBB)

7125 THE EFFECTS OF γ IRRADIATION ON REDUCING SUGARS OF LIVETINS OF CHICKEN EGG YOLK. Yoshinobu Nonami (Univ. of Niigata, Japan). Nippon Nogei Kagaku Kaishi, 37: 602-5(1963). (In Japanese)

It was found that egg yolk contains dialyzable reducing sugars and that these sugars increase during storage of shell eggs. It was also established that the qualities of shell eggs deteriorate markedly under γ irradation. Further research was done to investigate the reducing sugars of livetins of irradiated eggs and to correlate these with the dialyzable sugars of age-deteriorated eggs. Oil-treated fresh shell eggs of White Leghorns were irradiated with ^{60}Co to total doses of 1×10^5 and 5×10^5 R and livetins of irradiated eggs and control eggs were analyzed. It was concluded that reducing sugars of livetins are not decomposed during irradiation but the livetins probably were denaturated and the reducing sugars liberated from the proteins. (BBB)

7126 THE EFFECTS OF GAMMA IRRADIATION ON WHEAT GLUTEN. PART V. STUDIES ON THE DENATURATION MECHANISM BY SULFHYDRYL AND DISULFIDE GROUPS IN WHEAT GLUTEN. Masao Doguchi (Metropolitan Hygienic Lab., Tokyo). Nippon Nogei Kagaku Kaishi, 38: 328-33(1964). (In Japanese)

A 300-g specimen of wheat gluten was irradiated with ^{60}Co at five doses (40, 100, 300, 600, and 1000×10^4 rep). A 0.02N acetic acid extract of the irradiated gluten was made and centrifuged. Fractions of the extract were analyzed for protein content, and changes in specific functional groups on the protein were measured. The results showed that the total amount of -SS- radicals in gluten did not change under the irradiation dose of 300×10^4 rep, but a clear decrease occurred at 600×10^4 rep or over; however, -SH radicals underwent no difference from the control samples under 600×10^4 rep, but an increase occurred at 1000×10^4 rep or over; the amount of protein extracted increased with the radiation dose, while the -SS- and -SH groups showed ~ the same values in all specimens; radiation dose of 300×10^4 rep or over brought about increased polydispersity of the protein insoluble in 0.02N acetic acid. It was concluded that a radiation dose of 100×10^4 rep or under brings about only a change in hydrogen bonding in the secondary or tertiary structure of gluten, while a dose of 300×10^4 rep or over brings about the further destruction of -SS- bonds as well as a marked change in the configuration of the protein molecule. (BBB)

7127 THE EFFECTS OF IONIZING RADIATION UPON YEAST CELLS. Nobutane Mori. Nippon Univ. J. Radiation Med. Biol., 1: 1-12(Mar. 1963).

Studies on the effects of irradiation on yeast cells showed that yeast cells may be greatly influenced not only by external radiations but also by the induced radioactivity of a radioactive isotope that is added to a culture medium or by the induced radioactivity of an element mixed with the culture medium. The studies are reported as three separate experiments: effects of ^{60}Co radiation as an example of external irradiation; effects of administration of radioisotopes as an example of internal irradiation; and the biological ef-

fects of alpha particles produced by neutron capture of boron as an example of particular internal irradiation. (P.C.H.)

7128 THE EFFECTS OF NEUTRONS UPON THE GROWTH OF PIG ASCARIS. Hideo Hosoya, Kichiro Miyamoto, Eiji Endo, and Hiroko Kosasa. Nippon Univ. J. Radiation Med. Biol., 1: 17-21(Mar. 1963). (In Japanese)

Studies were made on the growth of pig ascaris eggs after irradiation of the eggs at the monocellular stage and cellular stages II–IV with various doses. When the eggs at the monocellular stage were irradiated with neutrons of $6.7 \times 10^{9F}/cm^2$ and $1.34 \times 10^{10F}/cm^2$, their growth was accelerated to some extent and hence larva formation was hastened. In the case of irradiation with $2.0 \times 10^{10F}/cm^2$ and $2.7 \times 10^{10F}/cm^2$, there was almost no difference between the experimental and control groups. It was presumed that the effects of irradiation were hardly exercised upon the growth of pig ascaris eggs. When the pig ascaris eggs at cellular stages II–IV were irradiated with neutrons of $6.7 \times 10^{9F}/cm^2$, their marked effects were not perceived, but a tendency toward acceleration of the growth of the eggs was observed. In the case of irradiation with $1.34 \times 10^{10F}/cm^2$, $2.0 \times 10^{10F}/cm^2$, and $2.7 \times 10^{10F}/cm^2$, cleavage was inhibited and a tendency for the growth of the eggs to be delayed was noticed. Such a tendency was more remarkable at the dose of $6.0 \times 10^{10F}/cm^2$ and larva formation was inhibited. Hence the disturbance of growth of pig ascaris eggs was apparently visible. (auth)

7129 THE EFFECT OF RADIATION ON CROCUS. Yoshikazu Mitsukuri and Kenki Arai. Nippon Univ. J. Radiation Med. Biol., 1: 22-30(Mar. 1963). (In Japanese)

Gamma radiation was applied to Crocus Mammoth Yellow, and the relation between bud formation from the first to last stage was observed. The morpho-physiological characters studied were: plant height, growing stems, number of leaves, color of leaves, tissue of leaves, length of leaves, flower shape, size of flower, flowering condition, condition of stamens and pistils, number of root, and condition of new bulbs. As the dosage was increased, the height of plants, growing stem, length of leaves, size of flower, flowering condition, condition of stamens and pistils, numbers of root, and condition of new bulbs, were found to be remarkable abnormal. Decrease of stoma on leaves, check of formation of chlorophyll, and decrease of root numbers, arose as changes in plant metabolism. Abnormally developed stamens in flower buds appeared; this phenomenon was attributed to the fact that the balance of both material, flowering accelerating substance, and flowering retarding substance, were broken by the γ rays. (auth)

7130 STUDIES IN MAMMALIAN RADIATION GENETICS. W. L. Russell (Oak Ridge National Lab., Tenn.). Nucleonics, 23: No. 1, 53-6(Jan. 1965).

Recent and current experiments on radiation genetics in mice are discussed. Reproductive cell stages, mutation rate, interval between irradiation and fertilization, effect of dose rate, nature of induced mutations, and neutron induced mutations are included. Studies with mice have helped to answer some basic questions in radiation genetics and have given a clearer understanding of the genetic hazards of radiation exposure of human beings. (P.C.H.)

7131 GAMMA RADIATION IN CURING OF ANIMAL MEALS FOR ZOOTECHNICAL USES. A. Morozzi, A. Begliomini, R. Coppini, and D. Massa (Istituto Zooprofilattico Sperimentale dell'Umbria e delle Marche, Perugia, Italy). Nuovi Ann. Igiene Microbiol., 15: 13-17(Jan.-Feb. 1964). (In Italian)

Experimental research was carried out on the application of gamma radiations for curing meat and fish flours, naturally and artifically contaminated by various strains of Salmonella. (auth)

7132 THE EFFECT OF THE UNSATURATED FATTY ACID COMPONENTS (OX SUBSTANCE) EXTRACTED FROM THE X-RAY IRRADIATED RABBIT LIVER OF AN EXPERIMENTAL TUMOR. Michio Yamamoto, Takeru Shiaku, Masatada Tanabe, Naomi Katumata, and Yoshihiro Hada (Okayama Univ., Japan). Okayama Igakkai Zasshi, 75: 695-7(Sept. 1963). (In Japanese)

X irradiation induces toxins in rabbit liver cells, one of which affects testis and the other bone marrow and spleen. The effect of the first toxin on Ehrlich ascites tumor and Yoshida subcutaneous sarcoma was studied. The liver, pancreas, lungs, and spleen were removed from a rabbit which was exsanguinated 24 hr after x irradiation at a dose of 3000 R. The so-called OX substance was extracted from the homogenized tissue and purified with the aid of alcohol, petroleum ether, ether, and acetone. About 2 million Ehrlich ascites tumor cells were transplanted into the peritoneum of a 15-g mouse, and 0.3 to 0.4 ml of a 2% preparation of OX substance in glucose solution was repeatedly injected intraperitoneally. In another experiment about 10 million sarcoma cells were implanted in thigh muscle of rats, and 0.6 ml of 2% OX substance emulsion was regularly injected into the tail vein starting 24 hr after the tumor implantation. The results showed that the application of the OX substance prolonged the life of the mouse bearing ascites tumors, resulting in the absence of an accumulation of ascitic fluid and disappearance of tumor cells. The intravenous injection of OX substance in the rat with the Yoshida tumor resulted in the prolongation of life and disintegration as well as disappearance of the tumor cells, suggesting OX substance has marked antitumor cell activity. (BBB)

7133 TREATMENT OF THE EYE WITH LARGE DOSES OF X RAYS WITH EFFECTIVE PROTECTION OF THE ANTERIOR THIRD. K. Arato and S. Eroess (Janos Hospital, Budapest). Ophthalmologica, 147: 313-18(1964). (In German)

In order to avoid damage to the eye when it is irradiated, four requirements must be met. The radiation beam must be defined sharply, the anterior pole must be Pb shielded, the tube must be positioned accurately, and eye movements must be prevented during the irradiation. A conical Cu tube, shielded with Pb, with adjustable nasal and temporal positioning bars has been constructed. A fixating mirror is attached to the frame by a ball joint. The focus-skin distance of the tube is 40 cm. The Pb shield is 6 mm thick, and the free opening is 22 mm. By this arrangement an 8-mm cross-section is shaded, so that the radiosensitive portion of the eyeball does not receive any direct radiation. The dose rate for 180 kv x rays is 31 R/min. From the temporal aspect 57% of the surface dose is received at the midline of the irradiated orbit at 28 mm, with a diffused radiation field of 2.2 to 4.3%. In the midline of the other orbit 32% of the surface dose is received, with diffusion of 1.8%. In the nasal aspect at 34 mm and 28 mm 77 and 57% of the surface dose is received. This indicates that the temporal bones and tissues are much thicker than the thin nasal membranes. The nasal field can be used with greater effectivity. Reflex eye movements must be prevented to keep the tumor directly within the radiation beam, and prevent injury to other radiosensitive areas. In infants and children who received a total dose of 8000 to 10,000 R, given at a rate of 250 to 300 R each second day, only a slight temporary erythema was observed. In adults who received 12000 R at a rate of 600 R each second day no skin effects were observed, and one patient even received 24,000 R in two fields without side effects. (BBB)

7134 GENERALIZED HYPEROSTOSIS INTERNA AND OSTEOSARCOMA AFTER WHOLE-BODY X IRRADIATION OF SWISS ALBINO MICE WITH HORMONALLY ACTIVE OVARIAN TUMORS. H. Cottier, H. Keller, and B. Roos (Universität, Bern). Pathol. Microbiol., 27: 458-66(1964). (In German)

Initial changes in bone found within 2 or 3 months after irradiation were studied histologically in 479 mice exposed to 600 R whole-body x radiation. These consisted of localized, peritrabecular increase of reticulum cells, fibroblasts, and fibrocytes in the metaphyseal areas, with subsequent extension of calcification throughout the marrow spaces. Reticulated bone was replaced by lamellar bone, with increased osteoclastic resorption, resulting in a mosaic of new bone. Blood cells that accompanied the final stages of development of the hyperostosis interna were

erythropoietic. The hyperostosis interna was observed only in female mice with dysplastic or neoplastic ovarian tumors. The ossification of the bone marrow space was most marked in mice where estrogen and androgen production was increased. Osteogenic sarcomas were observed only in irradiated females with ovarian tumors and generalized hyperostosis interna. The severity of the generalized hyperostosis interna was closely related to the degree of histological signs of continuous hyperestrogenic activity. This was true also of animals where osteogenic sarcomas were observed. The irradiated females with generalized hyperostosis interna showed a significantly higher incidence of osteogenic sarcomas than nonirradiated mice or irradiated males. (BBB)

7135 THE EFFECT OF ULTRAVIOLET LIGHT AND X-RAYS ON GROWTH AND MORPHOGENESIS OF OPHIOSTOMA MULTIANNULATUM. Angelica V. Hofsten (Uppsala Univ.). Physiol. Plantarum, 17: 221-30(1964).

Ophiostoma multiannulatum normally multiplies as budding conidia in a liquid synthetic medium, but if such cells are briefly irradiated with uv light (2537 Å), a conversion from conidial to hyphal growth is induced. This effect was noticed even at doses of uv (525 erg/mm^2) which will kill about 5% of the cells and is accompanied by depression in the rate of growth. The uv-induced hyphae had a low DNA content. The effect of uv on viability and growth was partly restored by exposure to visible light and such a photoreactivation also reversed the morphologic changes. Irradiation of budding conidia with x rays at doses (24,000 R) which killed up to 90% of the cells had a slight effect on the rate of growth of the surviving cells. However, these formed long hyphal cells with abnormal cytologic appearance. Although an increase in the x-ray dose delayed growth, this effect is less drastic than if a culture is irradiated with a uv dose, causing a similar decrease in the viable count. The growth morphology of cells treated with x rays was almost completely changed from conidial to hyphal. Besides these hyphae some vacuolated cells were seen which contained many small particles of unknown composition not observed before. The per cent survival after x irradiation is higher in Ophiostoma than in some bacteria and is more similar to that of budding yeast. The drastic change in cell morphology induced by both types of irradiation is probably due to an inhibition of the cell division mechanism caused by a delay in the DNA synthesis. The survival of uv-treated cells was increased by visible light. Many mutant strains of this ascomycete have been isolated after treatment of conidial suspensions with uv or x rays. (BBB)

7136 HEMATOLOGIC MANIFESTATIONS OF RADIATION EXPOSURE IN MAN. Niel Wald, George E. Thoma, Jr., and Goronwy Broun, Jr. (Univ. of Pittsburgh). Progr. Hematol., 3: 1-52(1962).

A review is presented on the hematologic manifestations of human radiation exposure, including both promptly appearing and more delayed effects resulting from acute and chronic doses. Recently developed methods used in such studies are considered as well as the resultant data. The implications of the findings in relation to the diagnosis and management of clinical cases, and the the formulation of decisions affecting the health of occupationally exposed workers and the general public are emphasized. Information obtained from pertinent animal experimentation are also introduced to illustrate concepts for which adequate supporting human data are not yet available. A detailed description of the acute radiation syndrome is given for the exposure of man to a single whole-body dose of rapidly delivered ionizing radiation on the order of 100 Rad. An analysis is provided of the clinical signs and symptoms and lab findings in the victims of nuclear criticality accidents, these data indicating that there are five well-defined clinical injury patterns into which patients can be grouped. The pertinent characteristics of each of these injury groups are summarized. A survey of hematologic findings revealed that there has been increasing emphasis on investigations beyond the enumeration of changes in the number and morphology of cells of the traditional types in the period after short-term radiation exposure. In newer areas of investigation, attempts were made to quantitate the effects of radiation on the dynamic stages of proliferation of the blood-forming tissue by measuring reproductive capability in various ways. On the basis of the investigations of human radiation leukemogenesis, which are reviewed in detail, it is accepted that an increased likelihood of leukemia follows a single, whole-body penetrating exposure of 100 Rad or more, and a short-term series of exposures totaling 500 Rad or more to a major portion of the human bone marrow. It also appears that a long-term, intermittent series of exposures may produce the same result. It was concluded that it appears well established that leukemia occurs in man as a late manifestation of radiation injury to the hematopoietic system received under a variety of exposure conditions. 253 references are included. (TCO)

7137 STUDY OF THE EFFECT OF γ-IRRADIATION ON GRAPES AND STRAWBERRIES. M. Tomana and O. Svabensky. Prumysl Potravin, 14: 43-5(Jan. 1963).

Fully-ripened white grapes in polyethylene bags were pasteurized with doses of 83,000, 415,000, and 830,000 Rad from a 5000-C ^{60}Co source. Subsequently, some of the grapes were stored in the polyethylene bags, and some were stored in the open. The appearance, color, taste, decrease in l-ascorbic acid, and decrease in the sugar content were measured and compared with controls immediately after irradiation and after 15 days of storage. The appearance and taste were also noted, and the microbial flora were examined and cultured after 15 days of storage. Unsatisfactory results were obtained because the grapes, which were too ripe, had been obtained 10 days after harvesting. In another test, fully-ripened strawberries (2 varieties) were irradiated with a dose of 415,000 Rad from a 50-C ^{60}Co source for 24 hr. Examination of the strawberries immediately after irradiation and after storage for 8 days showed that the strawberries were in good condition. It was concluded that fruits that are to be irradiated must be wholesome, undamaged, and not fully ripened. (OID)

7138 A STUDY OF PASTEURIZATION AND STERILIZATION OF MEAT BY IONIZING RADIATION. V. Preininger. Prumysl Potravin, 14: 49-55(Jan. 1963). (In Czech)

The preservation of beef and pork by using pasteurizing and sterilizing doses (5×10^4 to 2.1×10^6 Rep) of radiation was studied. In 11 of the tests, a 5000-C ^{60}Co source was used; in 5 tests, the samples were irradiated in a reactor with a mixture of γ rays and neutrons. The effects of tin and polyethylene wrapping were also studied, along with the effects of preservative additives (mainly l-ascorbic acid) to prevent changes in color, taste, and odor. Irradiation by γ rays and neutrons caused changes in color, odor, and taste, but– results with pure γ irradiation were considerably better. In raw meat, irradiation caused the formation of H_2S, methyl mercaptan, and other gases which affected its odor, color, and taste. Irradiation also caused a decrease in the lysine, glutathione, glycogen, thiamine, and vitamin B_1 content of the meat and an increase in the glutamic acid, asparagic acid, and alanine content. Pasteurizing doses of radiation (up to 10^6 Rep) were inadequate if the beef or pork was to be stored at room temperature, and a sterilizing dose from 1.2 to 2.1×10^6 Rep had to be used. (OID)

7139 EFFECTS OF EARLY ADULT X-IRRADIATION UPON EMOTIONAL DISPLAY IN THE AGED FEMALE BEAGLE: A NEGATIVE FINDING. Andrew K. Solarz (Univ. of California, Davis). Psychol. Repts., 15: 927-30(1964).

Adult female beagles (250) were tested for emotional display late in adult life after having been exposed or sham exposed to x irradiation at 10 to 12 months of age. The control dogs were interspersed in pens among experimentals. Emotional display was stimulated by the presentation of a person relatively strange to the kennel area. The dogs' responses were classified as friendly, wary, aggressive, or staying. No significant differences were obtained in the comparison of experimental and control groups in regard to frequency of dogs falling within each of the behavioral categories. (auth)

7140 MUTATIONAL MOSAICISM INDUCED BY X-, γ-RAYS AND ETHYLENE IMINE IN RICE. Hikoyuki Yamaguchi and Abdul Jalil Miah (Tokyo Univ.). Radioisotopes (Tokyo), 13: 472-6(Nov. 1964).

The comparative effects of ionizing radiations (x- and γ-rays) and ethylene imine of relatively low doses were studied, using dry seeds of variety Kinmaze in rice. There was a linear relationship between the mutation frequency and the dose of x- and γ-rays, and a significant difference of the mutation yield was not found within the two types of radiation used. For the materials irradiated with sufficiently low dose and treated with ethylene imine, the segregation ratios in X_1-ear-branch showed a strong deficit of recessives. With higher doses, however, the segregation ratios came nearer to the expected ratio of 0.25. The results are interpreted to indicate that two types of mutation, fractional and whole, are produced by mutagenic agents. (auth)

7141 THE EFFECTS OF VARYING DOSAGES OF IRRADIATION UPON STERNAL-MARROW REGENERATION. Marguerite P. Sykes, Florence C. H. Chu, Herbert Savel, Gianni Bonadonna, and Hazel Mathis (Sloan-Kettering Inst. for Cancer Research, New York; Memorial and James Ewing Hospitals, New York; and Cornell Univ., New York). Radiology, 83: 1084-8(Dec. 1964).

The effects of varying dosages of radiation to the sternal area were studied in 61 cancer patients. Five who received 2,400 R or less all showed complete bone-marrow regeneration. Sternal-marrow regeneration did not occur in 54 of 56 patients (96.5%) who received 3,000 R or more. Marked tumor-cell infiltration, however, was observed in the sternal sections of 2 additional breast cancer patients at ten and twenty-two months following x-ray therapy of 4,500 and 5,000 R. On the basis of the above data, it would appear that the critical dosage of radiation in relation to normal sternal marrow regeneration is in the range of 2,500 to 3,500 R delivered in two to four weeks. (auth)

7142 STRUCTURAL CHANGES IN THE FIBERS AND NERVE ENDINGS UNDER THE INFLUENCE OF X-RAY IRRADIATIONS. Ladislau Lazar, Tiberiu Morosh, and Ivan Kreps. Rev. Sci. Med., Acad. Rep. Populaire Roumaine, 5: 195-8(1960). (In Russian)

The nervous network of the tactile hair follicles (the preterminal segment in particular) underwent structural changes even after irradiation with small doses (1000 R). Large fibers and the motor endings were more susceptible to x irradiations than the thin fibers and the free or encapsulated nerve endings. The structural changes occurring after x irradiations were to a great extent caused by concomitant lesions of the blood vessels. (auth)

7143 CHANGES IN THE SEDIMENTATION RATE OF LEUKOCYTES DURING GYNECOLOGIC RADIOTHERAPY. Roberto Sermann and Giacomo Bellinvia (Università, Messina, Italy). Riv. Ostet. Ginecol. Prat., 44: 233-9(Mar. 1962). (In Italian)

Since leukocytes are relatively radiosensitive, they can offer a diagnostic criterion of radiation effects. The subjects studied who had epithelial or connective tissue neoplasms or lymphosarcomas showed a constant leukocyte sedimentation rate (LSR) before and after x irradiation, but in four cases of Hodgkin's disease the LSR was increased before the irradiation therapy and progressively became more normal toward the end of the treatment. Other changes in leukocytes were noted such as lymphopenia, leukopenia, and the progressively lower osmotic resistance of leukocytes which is manifested before the leukopenia appears. Cellular elements showing altered morphology are also noted, such as atypical monocytes, immature forms, lymphocytes with amitotic division and bilobate nuclei. Studies are also reported on the behavior of LSR in continuous gynecologic radiotherapy. Eighteen patients with uterine carcinomas and six other cases of hemorrhagic metropathy showed no relevant LSR changes during and after treatment (doses of 3000 R were used), but very close to normal values were seen. However, a small but constant increase of LSR at the end of the therapeutic cycle was seen both in radium-treated subjects and x-irradiated subjects. The concept is discussed that a high level of fibrinogen in the plasma is responsible for the modified sedimentation rate of the leukocytes. Changes in the LSR should also be considered in relation to other pathologic changes in blood, such as changes in the albumin/globulin ratio and increased globulin levels. (BBB)

7144 EFFECTS OF X-RAY THERAPY ON PLASMA 17-HYDROXYCORTICOSTEROIDS. V. Righi (Ospedale Civile, Ostiglia, Italy). Riv. Patol. Clin., 17: 703-14 (1962). (In Italian)

Changes in plasma 17-hydroxycorticosteroids and aldosterone were studied in eight patients undergoing postoperatory x-ray therapy following Halsted-type mastectomy for breast cancer. The effect of exogenous aldosterone on the level of plasma 17-hydroxycorticosteroids was also studied in these patients. Previous experiments in this field by other researchers have indicated that there was up to a four-fold increase in the level of plasma 17-hydroxycorticosteroids as the result of surgical trauma and anesthetic stress. Four of the patients received 2 mg of aldosterone per day in one liter of physiologic solution infused at a velocity of 60 drops per min beginning 24 hr prior to the radiation therapy. Fractional doses of 150 to 200 R were given to a total of 4800 to 5800 R. The level of plasma 17-hydroxycorticosteroids was measured before and during the radiation treatment using the Nelson and Samuels technique. The results showed that the level of plasma 17-hydroxycorticosteroids is raised by x-ray stress, as it is by other stresses. The level one day before radiation treatment was within a range of 8.2 and 13.6 mg/100 ml plasma for the eight patients. Six days after the treatment began the level of 17-hydroxycorticosteroids had risen to an average of 19.4 mg/100 ml. The increase was of the same degree in the patients who had been receiving aldosterone as in those who had not been given the hormone. This test demonstrated that the plasma 17-hydroxycorticosteroids are elevated by x-ray therapy and that the reaction is not blocked by aldosterone. (BBB)

7145 BRACHIAL PLEXUS PARALYSES THAT RESULT FROM X IRRADIATION. M. Mumenthaler (Medizinische Universitätsklinik, Bern). Schweiz. Med. Wochschr., 94: 1069-75(Aug. 1, 1964). (In German)

Evidence found at autopsy in 7 of 8 patients indicated a causal relation between x irradiation and brachial plexus paralysis. In 4 of the 8 who were operated on for mammary carcinoma, the paralysis occurred without signs of recurrence of the tumors. In 3 other patients the connective tissue surrounding the brachial plexus had become fibrotic, but without any indication of tumors. In these patients the radiation field had included the clavicular and axillary areas. In another patient the base of the neck had been irradiated ventrally and from the side. The radiation doses administered varied considerably, ranging from a minimum of 1700 R in a single field to a maximum of ~5000 R for a combined supraclavicular and axillary field. One patient had received 3065 R to the axilla in a single exposure. The symptom-free interval between irradiation and appearance of the first symptoms varied from 15 months to almost 12 yr. Severe pain is usually the predominant symptom. It is penetrating and disturbing, and is intensified by body movements. Spontaneous remissions of the pain and paralysis are extremely rare. Both upper and lower plexus paralyses are known, but complete involvement of the plexes is rare. The pathogenesis of the paralysis is not known precisely, but it is probably due to compression of the nerves by indurated scar tissue. Probably only surgical removal of this tissue from the nerve fibers can relieve the symptoms, and the earlier this is undertaken, the more likely the condition will improve. Even though there always is the possibility that brachial plexus paralysis may result, this is not a valid argument against energetic x-ray treatment of local lymphatic metastases or prophylactic irradiation of the supraclavicular region in mammary carcinoma. (BBB)

7146 THE EFFECT OF X-RAY IRRADIATION ON MUSCLE PHOSPHORYLASE. Atsushi Kudo (Nippon Medical School, Tokyo). Seikagaku, 35: 75-80(Feb. 1963). (In Japanese)

Muscle phosphorylase a and b were extracted from rabbit muscle and crystallized by Cori's and by Fischer's procedures. Care was taken so that both purified enzymes were free of the cofactors cystine and adenosinemonophosphate. The enzyme activity was measured by Cori's method, i.e., from the inorganic phosphorus released from the substrate (glucose-1-phosphate), using the Fiske-Subbarrow method. Two qualities of x rays were used: hard x rays (170 kvp 25 ma, and filtration: Cu 0.7 + Al 0.5 mm, and soft x rays (100 kvp, 25 ma, Al 1.0 mm). The enzyme activity was measured 20 min after irradiation. It was concluded from the results that phosphorylase a and b lost 50% of their strength after 100-kv x irradiation at a dose of 5000 R when the enzyme concentration was about 10^{-7}M; adenosine-5'-phosphate, pyridoxal-5'-phosphate, and cystine, when added to the enzymes before irradiation, showed strong protective action, the strength of this action for each cofactor following the above order; these three cofactors when added to the irradiated enzymes showed little effect in restoring enzyme activity; a 500 R dose of x irradiation on the mouse resulted in no detectable effect on the activity of muscle phosphorylase. (BBB)

7147 COMPLETE TECHNICAL REPORT OF "APPLICATION OF RADIATION-INDUCED MUTATIONS TO PLANT BREEDING" UNDER RESEARCH CONTRACT NO. 27 WITH IAEA. Seiji Matsumura Kihara Inst. for Biological Research, Yokohama, Japan). Seiken Jiho, No. 14, 57-112(Dec. 1962).

Detailed research was made on the application of radioinduced mutations to plant breeding. The program included fundamental studies, determination of optimum radiation dose and method, studies on mechanism of radioinduced mutations in cereals, comparative studies on mutations induced by various kinds of radiation, and practical use of mutations in crop plants and vegetatively propagated plants. (P.C.H.)

7148 INVESTIGATIONS OF COMBINATION INJURIES. I. IMPORTANCE OF TIME INTERVAL BETWEEN WHOLE-BODY IRRADIATION AND SKIN LESIONS FOR THE SURVIVAL RATE OF MICE. Hanns Langendorff, Otfried Messerschmidt, and Hans-Joachim Melching (Universität, Freiburg i. B.). Strahlentherapie, 125: 332-40(Nov. 1964). (In German)

An open skin lesion occupying about 5% of the body surface leads to a mortality of 7% in mice. If an animal with such a lesion is subjected to a whole-body irradiation of 510 R—corresponding to a LD 26/30—the mortality rises to 85 to 95% if the lesion is inflicted 2 to 8 days after irradiation. However, if the lesion is inflicted before irradiation, the mortality is not increased, but a tendency toward an increase of radioresistance was observed. The increased radioresistance seems to be parallel to the protective effect observed in laparotomy and splenectomy before and after sublethal whole-body irradiation. Possible causes changing the mortality in the case of combined damages are discussed. (auth)

7149 INVESTIGATION OF A BIOLOGICAL RADIOPROTECTOR. REPORT 58. AMINO ACID CONTENT IN LIVER AND KIDNEYS OF WHITE MICE AFTER WHOLE-BODY IRRADIATION. Christian Streffer and Hans-Joachim Melching (Universität, Freiburg i. B.). Strahlentherapie, 125: 341-51(Nov. 1964). (In German)

After whole-body irradiation the content of amino acids in the liver and kidneys of white mice did not increase in the same way as in spleen tissue. In both of the organs investigated (liver and kidney) the course of the changes in a amino acid concentrations was very similar. As observed in other enzyme systems that depend on Pyridoxal-5-phosphate, the content of serine and aminoethanol in the organs showed that the corresponding decarboxylase-activity decreases after irradiation. From the results it was concluded that in case of decarboxylation of glutamic acid and aspartic acid there is no inhibition of the enzyme processes. (auth)

7150 CAUSE OF DEATH AFTER IRRADIATION OF LOWER EXTREMITIES OF FROGS. Pierre Van Caneghem (Université, Liege and Université, Louvain, Belg.). Strahlentherapie, 125: 441-8(Nov. 1964). (In German)

Studies showed that the death of the frog (rana temporaria) after irradiation of the hind legs need not necessarily be attributed to the existence of a toxine liberated in the irradiated tissues. The loss of the epithelium, the functions of which are very important to amphibias for protection as well as for exchange with the environment, seems to be a sufficient cause for the death of these animals. (P.C.H.)

7151 EFFECTS OF uv RADIATION ON BACTERIOPHAGES. Georgine Ronto (Univ. of Budapest). Strahlentherapie, 125: 464-9(Nov. 1964). (In German)

Inactivation of bacteriophages T7 by uv light was investigated. The initial part of the dose-effect curve resembles a single hit curve. The primary event of the inactivation process seemed to occur in the H-bridges. Absorption measurements in the phage molecules irradiated with higher dosages showed that in the irradiated phage-DNA other processes besides splitting of H-bridges also occur. (auth)

7152 GROWTH, CATALASE, AND FAD ACTIVITIES IN E. COLI B, SH. FLEXNERI 3B, STAPHYLOCOCCUS 209P, AND MICE AFTER ^{60}Co IRRADIATION. Ming-Liang Lee and I-Hung Pan (National Taiwan Univ., China). Tai-Wan I-Hsueh-Hui Tsa-Chih, 61: 87-93(Jan. 28, 1962).

The organisms were exposed to single doses (up to 24,000 R) of γ radiation delivered at a dose rate of 90 R/min. Escherichia coli B and Shigella flexneri 3b showed growth inhibition at doses of over 4000 R, but no effect at doses lower than 2000 R. At doses between 2000 and 3000 R the growth inhibition was not marked. For Staphylococcus 209P the growth inhibition dose was much higher, at least 12,000 R. Higher sensitivity of E. coli B in the logarithmic phase than in the lag phase was noted. Bacteria in the lag phase irradiated with 8000 R recovered almost to the numbers in the controls after 9-hr incubation, but when irradiated in the logarithmic phase the growth was so markedly inhibited that even 10 hr after incubation it still had not fully recovered. A growth-inhibitory action in mice was also obtained. Thus 600 R was enough to induce retardation in growing mice. Catalase and FAD (flavin adenine dinucleotide) activities were also determined. After 2000-R irradiation the catalase activity in E. coli B was slightly increased, while that of FAD remain unchanged. In mice, the effect was more prominent; 600 and 1200 R were enough to cause significant decreases of both FAD and catalase in kidney, though not in liver. The results indicate that gram-negative bacteria are more sensitive to radiation than gram-positive bacteria. They also demonstrate the markedly higher radiosensitivity of the mammalian as compared with the bacterial organism. (BBB)

7153 MUTATION BREEDING IN TOBACCO. K. A. Patel and M. S. Swaminathan (Research Inst., New Delhi). Tobacco Sci., 5: 67-9(June 2, 1961).

The dose thresholds of different mutagens suitable for use in Nicotiana tabacum and N. rustica mutation experiments were studied. The mutagenic agents used included uv and x rays, neutrons, and ^{32}P β rays, as well as chemicals. Various chromosomal aberrations were observed at both mitosis and meiosis in the abnormal plants of the M_1 generation. At mitosis the cytologic effects include inhibition of mitosis, delayed mitosis, chromosome or isochromatid breaks, ring fragments, stickiness and clumping of chromosomes, liquefaction of chromatin material and the formation of acentric fragments, dicentric bridges, sticky bridges, laggards, and micronuclei at anaphase and telophase. During meiosis the following abnormalities were observed: nonsynchronized division, polyploidy, large number of fragments at diakinesis and metaphase, nuclear disintegration, stickiness and clumping, nonconjunction, nondisjunction, chromosomes lying off the plate, laggards, sticky bridges and abnormal microspores. In the M_2 generation of the thermal neutron-treated Natu variety, plants with broader leaves were observed lacking the conspicuous long tail of Natu. These plants resembled Natu in all other characters. In the M_2, M_3, and M_4 prog-

enies a wide range of variability occurred in all the treated varieties with regard to leaf size and number, plant height, and panicle length. Several plants far exceeded the control plants in leaf size and yield. It was clear that the range of variability for polygenic traits is greatly increased in irradiated populations and that by application of biometrical screening procedures it may be possible to isolate mutations superior in yield to the parent strain. Nicotine contents in M_2 plants of N. rustica var. N.P. 219 varied from 1.86 to 3.00% in the M_2 plants while that of the control was 1.56. The maximum content of 3% occurred with neutron treatment. In the variety N.P. 220, the range of values in control was 1.56 to 2.14, while the range in irradiated plants was 2.42 to 3.26. Thus, considerable variability for nicotine content can be induced by irradiation. No prominent variation in the types of mutations was induced by different mutagens. However, segregation for a chlorina character (yellow leaf) occurred only in the M_2 progeny of K-49 treated with 30,000 R of x rays after pretreatment with maleic hydrazide. (BBB)

7154 SOME PROBLEMS IN THE STUDY OF RADIATION EPIDEMIOLOGY. Austin M. Brues, Douglas Grahn, and Harry Auerbach (Argonne National Lab., Ill.). Trans. Am. Clin. Climatol. Assoc., 75: 102-10(1964).

Attempts that have been made in radiation epidemiology are discussed, along with some of the major problems in carrying out this type of study. The greater part of the positive epidemiological evidence available at present relates to leukemia as a sequela of irradiation. (P.C.H.)

7155 EFFECT OF IONIZING RADIATION ON PLANT GROWTH AND DEVELOPMENT. S. O. Grebinskii. Usp. Sovrem. Biol., 57: 90-8(1964).

A brief survey was made on the effects of ionizing radiation on plant cells. Special attention is given to radiosensitivity of plant tissues and seeds. 67 references are included. (TCO)

7156 THE USE OF ANTIBIOTICS IN THE TREATMENT OF ACUTE IRRADIATION DISEASE. Jan Pospisil and Zdenek Dienstbier (Veterinary Research Center, Prague and Charles Univ., Prague). Vet. Med. (Prague), 9: 237-44(July 1964).

Dogs were irradiated with a whole-body dose of 600 R by means of ^{60}Co and a curative effect due to the administration of penicillin and streptomycin was found. There was no difference in the post-irradiation changes in the peripheral blood-count between the group treated with antibiotics and the control group. The effectiveness of antibiotic treatment in the course of active irradiation disease is discussed. (OTS)

7157 ON THE INFLUENCE OF IONIZING RADIATION ON PROTEINIC NITROGEN AND POTASSIUM. Vilma Kalousova and Josef Janicek (Veterinary Research Center, Prague). Vet. Med. (Prague), 9: 303-10(July 1964).

The influence of radiation on proteinic nitrogen and potassium was studied in the muscular tissue of rats. A comparison was made between the influence of a medical deep x-ray device and an industrial defectoscopic x-ray device. Higher mortality was caused by the industrial device. The irradiation did not influence substantially the levels of N and K. In superlethal doses a decrease of the K content and of the K/N ratio was observed. (OTS)

7158 RADICAL NECROTOMY IN FROST BITES COMBINED WITH RADIATION INJURIES. M. A. Lushchitskii. Voenno-Med. Zh., No. 5, 43-6(May 1962). (In Russian)

In experiments with 187 rabbits (35 irradiated only, 53 treated with cold on the extremities, and 99 both irradiated and frost-bitten), irradiation and frostbite were mutually aggravating. Radiation sickness was more severe and the death rate was higher in animals given the combined treatment. In this case the frostbite was not accompanied by dry necrosis. Early radical necrotomy (after 4 to 5 days) with joint or skin autoplastics and the use of antibiotics significantly decreased the death rate and gave a more favorable outcome. (au-trans)

7159 ACUTE RADIATION SICKNESS WITH THE SYNDROME OF PRIMARY GASTRO INTESTINAL TRACT INJURIES. V. A. Rezontov, A. V. Popov, and P. S. Ponomarev. Voenno-Med. Zh., No. 8; 36-9(Aug. 1962). (In Russian)

Clinical and experimental animal data are examined, and the clinical picture of radiation sickness is summarized. No references. (IIC-M.G.)

7160 SEQUELAE OF ACUTE RADIATION SICKNESS. E. I. Antipenko. Voenno-Med. Zh., No. 2, 43-9(Feb. 1963). (In Russian)

The after effects of radiation sickness, as observed in animal experiments and patients, are summarized. No references. (IIC-M.G.)

7161 EFFECTS OF SMALL DOSES OF IONIZING RADIATION ON HUMAN ORGANISM. V. V. Rozin. Voenno-Med. Zh., No. 8, 22-8(Aug. 1962). (In Russian)

Literature data characterizing the biological action of ionizing radiation in long- and short-term exposures are reviewed. Background irradiation both external and internal, is from natural radioactive elements (U, Th, Ra, ^{14}C, and ^{40}K) and cosmic rays. Occupational exposure of radiologists, fallout, atomic bomb, and experimental data are mentioned. The effects are broken down into categories: aging and length of life; gonads, including genetic changes; and blood and blood-forming agents. (IIC-M.G.)

7162 THE EFFECT OF GAMMA-IRRADIATION, THERMAL BURN, AND ACUTE LOSS OF BLOOD ON THE DEVELOPMENT OF TETANUS TOXICOINFECTION. (EXPERIMENTAL STUDY). G. I. Kremlev. Voenno-Med. Zh., No. 11, 29-30(1963).

Thermal burns and total gamma irradiation (500 R) facilitated the occurrence and aggravated the course of tetanus toxicoinfection in rabbits. The disease and death rates of burned and irradiated animals were four or five times higher than those in the controls. In the irradiated animals and those with burns, the active immunity they had earlier sharply decreased, and despite the more than 0.01 and less than 0.05 A.E./ml of tetanus antitoxin present, the animals proved to be practically unprotected against a dose of tetanus pathogen, which was nonlethal to immunized animals. (OTS)

7163 FUNCTIONAL AND MORPHOLOGICAL CHANGES IN CERTAIN ORGANS AND SYSTEMS AS A RESULT OF CHRONIC RADIATION SICKNESS. A. N. Kishkovskii. Voenno-Med. Zh., No. 8, 39-44(Aug. 1962). (In Russian)

Adult rabbits (193) were whole-body x-irradiated daily with 5 to 25 R to a total of 800 to 1500 R; twenty-five controls were used. The respiratory system, gastrointestinal tract, and lymphatic system were examined at times from several months to three or more years. The detailed results indicated significant damage to all these systems. The changes observed largely determine the clinical picture of radiation sickness. (IIC-M.G.)

7164 HEALING OF CLOSED FRACTURES OF BONES DURING CHRONIC RADIATION SICKNESS. A. B. Rusakov. Voenno-Med. Zh., No. 8, 44-6(Aug. 1962). (In Russian)

Experiments were done on 20 experimental and 20 control rabbits. The experimental were x-irradiated with 2 R daily to a total of 1200 R, and closed fractures were made in both bones of the right foreleg the day after the irradiation stopped. Controlled blood studies were made, and weight, appetite, fur, and the nature and time of placing weight on the extremity were observed. Both x rays and histological data indicated 7 to 14 days' delay in callus formation in the irradiated animals. The time of repair then rapidly increased, eventually becoming somewhat faster in the irradiated animals. (IIC-M.G.)

7165 EFFECT OF X-IRRADIATION ON THE MORPHOLOGY OF SPORE-FORMING BACTERIA. Zh. Safiyazov. Vopr. Biol. i Kraevoi Med., Akad. Nauk Uz. SSR, Otd. Biol. Nauk, No. 4, 118-22(1963).

Twenty-four-hour cultures of the vegetative cells of various spore-forming bacteria were exposed to various doses

of x irradiation, after which they were plated on meat-peptone agar and incubated for 24 hours at 34°C. Colony counts on the following day showed that, at a dose of 6 kR, the cultures of B. megaterium No. 3, B. megaterium var. Mutiliate, and B. longissimus had survival rates of 53, 66, and 54%, respectively. In cultures of B. subtilis 36 and 306, the survival rate at the same dose was 37.2 and 30%, respectively. With an increase in dosage up to 100 kR the survival rate decreased proportionally. The sublethal dose for all the cultures but one was 100 kR, which was lethal for B. subtilis 306. A dose of 150 kR was lethal for all the cultures. After a dose of 6–12.5 kR, cell division was retarded resulting in formation of giant cells. It was concluded that the radiosensitivity of the vegetative forms of spore-forming bacteria is about equal to that of their asporogenous strains. (OTS)

7166 STUDY OF ADOLESCENTS EXPOSED IN UTERO TO THE ATOMIC BOMB, NAGASAKI, JAPAN. I. GENERAL ASPECTS: CLINICAL AND LABORATORY DATA. Gerard N. Burrow (Yale Univ., New Haven), Howard B. Hamilton, Zdenek Hrubec, Kichiro Amamoto, Fumiko Matsunaga, and A. Bertrand Brill. Yale J. Biol. Med., 36: 430-44(June 1964).

A study was made of 286 Nagasaki adolescents, aged 13 to 14, to determine possible differences in growth and development attributable to in utero exposure to the atomic bomb. Three groups were compared: Group I, whose mothers were within 2000 m of the hypocenter, Group II, whose mothers were located between 3000 to 4999 m, and Group III, whose mothers were not in the city at the time of the bombing. Over 50% of the mothers of the exposed children had estimated radiation doses of 40 to 459 Rad, which is probably a biologically significant dose (exposure in utero to doses as small as 40 Rad can damage the human fetus). A significantly higher frequency of mental retardation and minor congenital malformations was found in Group I males, but not in the females. Group I females who were in the first trimester of gestation at the time of the bomb and whose mothers experienced the acute radiation syndrome had poorer visual acuity than comparable children of asymptomatic mothers, but because of the small sample this finding is of dubious significance. Parasitic infestation in Group I was significantly greater than in the other groups, Trichocephalus and Ascaris infestation accounting for the higher prevalence. This finding may be associated with different dietary and living habits. No cases of leukemia or malignancy were found, but the sample was not large enough to detect even a tenfold increase in incidence. No consistent significant differences attributable to a radiation effect were noted among the comparison groups in regard to radial pulse, blood pressure, and hematologic and urine tests. For females the mean hemoglobin value was significantly higher in Group I than in the other two groups, but the reasons for this difference are not clear. A corresponding similar rise in the hematocrit and red-cell count was also noted. (BBB)

7167 STUDIES ON AMYLASE ACTIVITY OF γ-IRRADIATED GROUNDNUT SEEDS DURING GERMINATION. G. M. Patel and K. C. Patel (Sarder Vallabhbhai (University), Vallabhvidyanagar, Gujarat State, India). Z. Naturforsch., 19b: 1017-20(Nov. 1964).

Amylase activity of groundnut with reference to gamma radiation in the range from 10 to 120 kr and the period of germination is discussed. Dry seeds contained little amylase activity. Amylase activity were found to increase with the period of germination and after reaching a maximum value it once again decreased. Radiation had inhibitory effects on this activity. Amylase activity was newly formed during the sprouting of seeds. Ascorbic acid produced during germination of these seeds also inhibited the amylase activity. (auth)

7168 EFFECTS OF RADIOACTIVE DECAY ON THE AUTONOMOUS REPLICATION OF AN ESCHERICHIA COLI EPISOME. Yukinori Hirota and Hisao Uchida (Tokyo Univ.). Z. Verebungslehre, 95: 184-94(1964).

Fragments of the E. coli F_{13} episome resulting from the disintegration of incorporated ^{32}P atoms demonstrated that fragments replicate. The fate of the fragments created by the breakage differs according to whether the fragment in question represents a part distal or proximal to the origin of the original F_{13} episome. (BBB)

7169 STUDIES OF THE GROWTH AND MULTIPLICATION OF STREPTOCOCCUS BOVIS AFTER CONTINUOUS X IRRADIATION. Johs. Brueggmann and D. Giesecke (Universität, Munich). Zentr. Bakteriol. Parasitenk., Ab. I Orig., 192: 39-53(1964). (In German)

A culture of S. bovis was irradiated at rates from 6 to 30 kr/hr. At prearranged time intervals the irradiated culture was sampled to measure the cell mass, cell count, glucose level, and cell size. The rate of increase in cell mass decreased as the dose rate was increased over the range of 18 to 30 kr/hr. At 30 kr/hr there was a marked prolongation of the exponential growth phase, although the maximal value of the bacterial mass attained was not altered. Glucose utilization was not affected. With high radiation dose rates the initial phase was prolonged, the rate of cell increase was diminished during the exponential phase, and the max numbers of cells finally produced was decreased. Both cell growth and cell division were inhibited in proportion to increases in dose rates. The radiosensitivity of cell division increased with the developmental status of the cells. The inhibition of cell division consisted of increases in the average cell volumes, and increases in the numbers of multicellular units. These effects were related to the dose rates used and to the developmental stage of the organisms. In terms of cell volume and multicellular units, the radiation effects decreased as the cells advanced in maturity. The cell sizes were increased most when the radiation was given before the beginning of the exponential growth phase. The average numbers of multicellular units produced also decreased when the radiation was administered at later stages of the growth cycle. (BBB)

7170 STUDIES OF THE EFFECTS OF IONIZING RADIATION ON THE FINE STRUCTURE OF LIVER AND SPLEEN OF MICE USING AN ELECTRON MICROSCOPE. K. Morgenroth. Thesis, Münster, Ger., Universität, 1963. 71p. $2.00(Gmelin, AED-DISS. 63-690). (In German)

The spleen and liver of mice, which were irradiated with 200–9000 R ^{60}Co γ rays and 200 kv x rays and sacrificed after various times, were studied using electron microscopy. Degeneration, latency, and regeneration of tissues were observed. Results indicate that the endoplasmatic reticulum can be regarded as a sensitive indicator for cell changes. (Gmelin Inst.)

7171 RADIATION EFFECTS OF Co^{60} IN YEAST CELLS. S. Czichelski. Thesis, Münster, Ger., Universität, 1964. 74p. $2.00(Gmelin, AED-DISS. 64-101). (In German)

The effects of radiation of yeast cells of the type Saccharomyces cerevisiae with 200 kev x rays and ^{60}Co γ rays were investigated. The average RBE value is 0.96. Induced radiation damage was found to depend on dose (100–380 kR) and decreases continuously with time being reduced to 0 after 100–170 hr. This is explained by free radical production. (Gmelin Inst.)

7172 PHYSICAL AND BIOLOGICAL PROPERTIES OF IONIZING RADIATION AND EXPERIMENTAL STUDIES WITH ANIMALS USING Co^{60} γ RAYS. G. Busch. Thesis, Münster, Ger., Universität, 1964. 85p. $2.00(AED-DISS. 64-99). (In German)

The biological effectiveness of ^{60}Co γ radiation was compared with 200 kv x rays. Six week old male mice were irradiated with doses between 270 and 20,000 R. RBE for weight loss was 1.16 and for 50% mortality 1.03. It was concluded that the biological effectiveness for ^{60}Co γ rays is practically the same as for x rays. (Gmelin Inst.)

7173 HAPLOIDY INDUCED BY X IRRADIATION IN PETUNIA HYBRIDA. I. M. Khan. Thesis, Cologne, Universität, 1963. 31p. $2.00(Gmelin, AED-DISS. 63-615). (In German)

Petunia hybrida were x irradiated with 1700 R at 170 kv. The properties of one plant of the next generation were

studied. After some time this plant had haploid sprouts, which were grown as cuttings. Reasons for the elimination of one chromosome set are discussed. (Gmelin Inst.)

7174 THE EFFECTS OF 200-KV X RAYS AND COBALT-60 GAMMA RADIATION ON THE REPRODUCTION OF YEAST CELLS. Claus Werning. Thesis, Munster, Ger., Westfaelische Wilhelms-Universität, 1962.

The effects of 200 kv x rays and ^{60}Co γ rays on plant cells were studied. Three groups of yeast cells were irradiated with each of the types of radiation for a total of 6 experimental groups. The three levels of radiation used were 60,000, 120,000, and 190,000 R. The results were displayed graphically, by photography, and tabulated for comparison. The results of the experimental studies showed that division of the yeast cells was inhibited by the x irradiation and by the radiation from the ^{60}Co. The effects to prevent division of the cells increased directly with the radiation dose used, but it was not possible to find any significant difference between the two types of irradiation as measured by their maximum effects observed after 24 hr. After 48 hr, cells that had received 60,000 and 120,000 R recovered their ability to reproduce, but after a dose of 190,000 required 72 hr. Directly after irradiation with 120,000 and 190,000 R the cell structures assumed the form of "gigacells," appearing greatly enlarged. Within 24 hr microscopic examination frequently showed agglomeration and clumping of dead cells. (BBB)

7175 PRODUCTION AND UTILIZATION OF RADIATION VACCINES AGAINST HELMINTHIC DISEASES. (International Atomic Energy Agency, Vienna). Technical Reports Series No. 30. 1964. 93p. (STI/DOC/10/30). $2.00; Sch 42,-; 12s.stg; F.fr.8,-; DM 6.40 (IAEA).

Applications of ionizing radiation for the manufacture of vaccines against certain helminthic diseases in man and domestic animals are discussed. The major helminthic infections in man are parasitic nematodes, such as hookworm, Ascaris, the filarias, Trichuris, Strongyloides, Enterobius, Trichinella, and trematodes such as Schistosoma. In domestic animals the major helminthic infections include nematodes of the gastrointestinal tract and the lungs of cattle and sheep, Strongyloids in horses, and liver flukes in ruminants. The life cycles of many of these parasites are complicated, requiring an obligate period of free life or life in an intermediate host during passage from one definitive host to another. Within hosts they accumulate by additions from without, and not by multiplication as do bacteria. The damage they produce is referable not only to their excessive accumulation but also to traumatic effects due to their movements within the bodies of their hosts. The ideal method of attack against helminthic infections is to interrupt the life cycle at some vulnerable stage, but this has proved difficult to achieve. The protection of human and animal hosts by vaccines against the parasites has proven more effective. The use of irradiated larvae for the immunization of animals against infection and the development of irradiated vaccines against parasitic infections are discussed. (C.H.)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 7521.

7176 (ANL-6906(p.78-80)) ATTEMPTS AT RADIATION PROTECTION BY COMPOUNDS RELATED TO 3-AMINO-1,2,4-TRIAZOLE. Robert N. Feinstein and John E. Seaholm (Argonne National Lab., Ill.).

A number of chemical compounds related to 3-amino-1,2,4-triazole were evaluated for their protective effects against radiation injuries in mice. Results indicated that they have a very low level of radioprotective activity. These compounds were tested previously as inhibitors of catalase activity in vivo and in vitro. No direct correlation was found between the catalase inhibitory properties and radioprotective properties of the compounds tested. (C.H.)

7177 SENSITIZATION OF TUMOURS CELLS TO γ-RAYS BY MEANS OF RADICAL REACTION INHIBITORS. G. G. Afanasiev, L. P. Lipchina, and I. I. Pelevina (Inst. of Chemical Physics, Moscow). Acta Unio Intern. Contra Cancrum, 20: 1213-15(1964).

The possibility of sensitizing malignant cells toward radiation with radical reaction inhibitors was found to be possible. These compounds belong to the class of phenols and display a radiomimetic effect. Thus it was expected that the combined effect of inhibitors and irradiation would be additive. However, treatment with inhibitors prior to irradiation (Ehrlich ascites carcinoma) resulted in an effect considerably stronger than the additive one with respect to chromosome aberrations. The potentiating factor appeared to be 1.58. (auth)

7178 RADIOSENSITIZATION OF TUMORS WITH PYRIMIDINE DERIVATIVES. R. Polkina, M. Bychenkova, and L. Zalesskaya (Inst. of Oncology, Leningrad). Acta Unio Intern. Contra Cancrum., 20: 1219-20(1964).

The fact that rapidly growing, proliferating cells are known to be more highly sensitive to ionizing radiations suggested the possibility of attaining radiosensitization by using certain pyrimidine derivatives with stimulating activity on processes of proliferation. Experiments with Metacil (4-methyluracil) and Pentoxil (5-oxymethyl-4-methyluracil) are reported. Mice of a mixed breed with subcutaneously transplanted Ehrlich carcinoma or melanoma were used. Sensitivity of tumor tissue to radiation was raised effectively in a number of experiments by Pentoxil treatment (100 mg/kg daily doses for 3 days, or 80 mg/kg for 5 days prior to irradiation). In the experimental group percentages of tumor growth inhibition proved to be 1.5 to twice as high as in irradiated group. A similar radiosensitizing effect upon tumors was exerted by Metacil. (auth)

7179 CHEMICAL PROTECTION AGAINST X-IRRADIATION DAMAGE. J. R. Maisin and A. Leonard (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Acta Unio Intern. Contra Cancrum, 20: 1221-2(1964).

The distribution of tritium labeled AET was studied in normal and cancerous tissues. Labeling of the different organs is presented and compared in normal and tumor-bearing mice (epithelioma of the ovary, breast, adenocarcinoma, reticulum cell sarcoma, melanoma, angioreticulosarcoma, and grafted spindle-cell epithelioma of the skin). (auth)

7180 THE USE OF PROTECTIVE SUBSTANCES FOR DIFFERENTIAL CHANGES OF RADIOSENSITIVITY IN NORMAL AND TUMOR TISSUES. E. N. Tolkacheva and N. I. Shapiro (Inst. of Biophysics, Moscow). Acta Unio Intern. Contra Cancrum, 20: 1223-5(1964).

The results of the action of radioprotective substances on normal tissues and on tumors are presented. Aminoethyl-isothiuronium (AET), serotonin, mexamine (5-methoxytryptamine), cystinamine, and diethylstilbestrol were tested in various ways and time intervals on transplantable tumors. It appears that under the most favorable conditions, when the tumor is entirely devoid of the protector, the dose of irradiation can be increased without enhancing the injurious radiation effect on normal tissues. Protection of the tumor occurred when inadequate concentration of the substances in tumors was observed during exposure. The use of these substances for radiotherapy of tumors is discussed. (auth)

7181 EXPERIMENTS ON INFLUENCING THE RADIOSENSITIVITY OF ANIMAL TUMOURS BY SH-COMPOUNDS. H. J. Altenbrunn and R. Huber (Forschungsgemeinschaft, Deutsche Akademie der Wissenschaften, Berlin). Acta Unio Intern. Contra Cancrum, 20: 1230-2(1964).

The effects of β-mercaptoethylamine (MEA) and S-β-aminoethylisothiuronium (AET) on oxidative phosphorylation in irradiated and non-irradiated mitochondria of transplantable lympho-sarcoma in ascites form in white rats were investigated. Isolated mitochondria and also isolated tumor mitochondria were found to be radioresistant. Their functions were not influenced. Upon irradiation

of washed tumor cells or irradiation of tumor-bearing animals the metabolic activity of the isolated mitochondria was considerably decreased. Protective SH-compounds administered before radiation increased respiration and phosphorylation, which resulted in an increase of the P/O-quotient. MEA and AET lost their protective effect during fractionated irradiation in the case of both tumorous and normal tissues. (P.C.H.)

7182 SOME RES EFFECTS INFLUENCING RADIATION SURVIVAL TIME. A. Szanto (Medical Univ., Budapest). Acta Unio Intern. Contra Cancrum, 20: 1233-5 (1964).

The influence of non-specific protective system of mammalian blood sera on the survival rate of irradiated animals through Properdin system was investigated. Contradictory results were obtained depending upon the dose and the time-factor of the pre-treatment with Zymosan. As the initial step in Zymosan action, circulating Properdin vanishes, thus its production is enhanced. Whole-body radiation given during the period of lower Properdin titer or the lowering of the level by large doses of Zymosan administered in the early post-irradiation period diminished survival rate markedly. Zymosan did not alter — in itself — either survival rate or RES activity. It is suggested that the action of Properdin is in controlling toxic and/or bacterial agents invading the organism during the post-irradiation period. (auth)

7183 POSSIBLE WAYS OF OVERCOMING RAY-CAUSED COMPLICATIONS BY AUTOTRANSPLANTATION OF BONE MARROW IN TREATMENT OF TUMORS. (EXPERIMENTAL FINDINGS). G. S. Strelin (Medical Center of Radiology, Leningrad) and N. K. Shmidt. Acta Unio Intern. Contra Cancrum, 20: 1236-7(1964).

A comparison was made of the survival rate and the red blood cell count after a single and a fractionated x irradiation between rats with screening of a part of the bone marrow without bone marrow transfusion and animals with screening of a part of the bone marrow followed by its intravenous administration. In the first group the survival rate was 15–20% and in the second 45–65%. In the second group, the leukocyte and erythrocyte counts increase more rapidly. The use of this model experiment for overcoming x-ray complication during treatment of patients with tumors is presented. (auth)

7184 THE COMBINATION ADENOSINE TRIPHOSPHATE + DIPHOSPHOPYRIDINE NUCLEOTIDE AS RADIOPROTECTOR IN EMBRYONAL CELLS. L. Verga and F. Coucourde (Università, Pavia, Italy). Boll. Soc. Ital. Biol. Sper., 37: 1171-3(Dec. 15, 1961). (In Italian)

Chicken embryos were inoculated with glycoside phosphorilates, ATP, or ATP + DPN at the 60th hour of incubation and exposed to a single dose of 180 R. The karyokinetic activity was determined 4 hrs later. X radiation reduced the karyokinetic activity. All of the substances tested protected this activity, but ATP + DPN showed a marked restorative effect. (J.S.R.)

7185 ON THE REASONS FOR THE PROTECTIVE ACTION OF BACTERIAL ANTIGENS IN ACUTE RADIATION SICKNESS. M. I. Ravich-Shcherbo and L. G. Prokopenko (Kursk Medical Inst., USSR). Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 1327-9(Dec. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 36-8 (Dec. 1963).

Studies were made on the reasons for the protective action of bacterial antigens on the production of antibodies against human serum proteins, associated with irradiation of the animals in a dose of 1000 R. By comparing the dynamics of antibody accumulation and plasmacytic reaction in the regional and remote lymph nodes of irradiated rabbits immunized prior to the irradiation with Bact. paracoli vaccine, it was concluded that the cause of protective effect of preliminary immunization lies in the increased number of plasmacytes in the lymph nodes caused by this immunization. (P.C.H.)

7186 COURSE AND TREATMENT OF RADIATION SICKNESS IN MAN. M. Skalka (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Casopis Lekaru Ceskych, 103: 1025-30(Sept. 11, 1964).

A review of contemporary knowledge of the subject is presented. The damage must be evaluated by means of clinical and laboratory examinations. The treatment consists mainly in care of the general condition and personal hygiene. Water and ion balance must be maintained, hemorrhagic diathesis and anemia should improve. Antibiotics and blood transfusions may be used as prophylactics. Glucocorticoids are contraindicated. Internal contaminations should be treated by a radiotoxicologist. (OTS)

7187 PREVENTION OF NUCLEAR CHANGES IN IRRADIATED RAT THYMOCYTES BY NICOTINAMIDE. J. F. Whitfield, H. Brohee, and T. Youdale (C.C.R.-EURATOM, Ispra, Italy). Exptl. Cell. Res., 36: 335-40(Nov. 1964).

Cytological studies showed that nicotinamide added to suspension cultures of thymocytes of rats immediately to 2 hr after x irradiation either retarded or prevented the development of the cytological symptoms of nuclear damage and cell death. (P.C.H.)

7188 THE EFFECT OF 5-BROMODEOXYURIDINE ON THE RECOVERY PHENOMENON IN SUB-LETHALLY IRRADIATED CELLS. J. H. Kim, M. L. Eidinoff, N. Delihas, and J. S. Laughlin (Sloan-Kettering Inst. for Cancer Research, New York). Exptl. Cell Res., 36: 411-15(Nov. 1964).

Recovery phenomena in sub-lethally irradiated mammalian cells in culture were studied after treatment with 5-bromodeoxyuridine to examine whether the general shape of the recovery curve could be altered when DNA thymine was partially replaced by 5-bromouracil. The extent of replacement of thymine in the H.Ep. No. 1 and HeLa S-3 cells by 5-bromouracil was about 1 and 12%, respectively. The recovery was evident even after treatment with 5-bromodeoxyuridine and the pattern of the recovery curve was not appreciably altered in both the H.Ep. No. 1 and HeLa S-3 cells. (auth)

7189 INFLUENCE OF ALCOHOL AND LARGACTIL ON THE RESISTANCE OF THE ORGANISM TO IONIZING RADIATION. L. A. Dimitrov (Bulgarian Academy of Sciences, Sofia). Izv. Inst. Po Fiziol. Bulgar. Akad. Nauk., 6: 263-70(1963). (In Bulgarian)

Mortality rate was determined after x irradiation of animals treated with alcohol and Largactil, and the changes in the distribution of thiamine in the organs and the incorporation of radiosulfur into the tissue proteins were studied in 334 rats and 17 dogs. It was shown that alcohol, given systematically over the course of 1 to 4 months before irradiation and 3 days after irradiation at a dose of 15 ml/kg (25% solution), decreases the radiosensitivity in rats; Largactil, administered ½ to 1 hr before x irradiation (800 R), decreases mortality, especially at a dose of 20 mg/kg. Alcohol, Largactil, and x irradiation, at various time periods induced similar changes in the distribution of radioactive thiamine. The significance of these findings and possible explanations of the mechanism of the protective action of these substances are discussed. (BBB)

7190 THE PROTECTIVE EFFECT OF CHLOROQUINE AGAINST ULTRAVIOLET-INDUCED BIOCHEMICAL CHANGES. Ryohei Ogura and John M. Knox (Baylor Univ., Houston, Tex.). J. Invest. Dermatol., 42: 461-4(June 1964).

Attempts were made to determine whether oral administration of chloroquine could prevent certain biochemical changes that follow uv exposure. Rats were fed chloroquine diphosphate at a level of 0.25 g/kg of diet. Biochemical changes, particularly sulfhydryl content, were followed in the serum and epidermis of these rats. The polarographic procedure was used after precipitation with sulfosalicylic acid to determine changes in mucoprotein. In serum from untreated animals the usual postirradiation response of both sulfhydryl and the polarographic filtrate wave height was an increase in values. Disulfide, however, was decreased. In chloroquine-fed animals these changes were appreciably inhibited; disulfide actually increased. In samples of nonirradiated epidermis, chloroquine decreased the polarographic protein wave height but did not alter sulf-

hydryl and disulfide concentrations. After irradiation, all three of the analyzed items showed a decrease in values. Chloroquine inhibited the decrease in both sulfhydryl and the filtrate reaction but did not prevent changes in disulfide concentration. An analysis of total sulfhydryl revealed that uv irradiation normally lowers or eliminates non-protein-bound SH and that chloroquine provides protection. The drug had no statistically significant effect on protein-bound SH. It is concluded that denaturation of serum protein occurs after uv exposure. Adding chloroquine to serum prevents these changes. In this experiment oral chloroquine partially inhibited uv-induced biochemical alterations in both serum and epidermis. (BBB)

7191 THE COMBINATION OF HYPOXIA AND CYSTEAMINE TREATMENT IN PROTECTING MICE FROM WHOLE-BODY IRRADIATION. Jennifer Shewell, E. A. Wright, D. K. Bewley, and Ann Silvester (St. Mary's Hospital, London). J. Pathol. Bacteriol., 88: 61-71(July 1964).

Attempts were made to achieve maximal hypoxic protection in mice by making the animals breathe pure nitrogen for the longest tolerated period, and giving irradiation (8-Mev electrons) in the last few seconds of this period; some animals were further protected by prior injections of cysteamine (200 mg/kg body wt). Doses of radiation varied from 752 to 2360 Rad. At all five doses tested, 12-week-old mice protected with both nitrogen hypoxia and cysteamine combined survived longer than animals protected with nitrogen alone. For example, 31% of mice subjected to 2113 Rad after combined protection survived 30 days, whereas no mice survived the same dose after nitrogen hypoxia only. Cysteamine injection alone protected 47% against 1088 Rad. These figures are compared with the 55% of unprotected animals surviving 752 Rad. This gives protective factors, or dose reduction factors, of 2.3 for nitrogen hypoxia, 1.5 for cysteamine, and 2.8 for cysteamine and nitrogen together. With younger mice (5 weeks old) 37% of the controls survived 745 Rad and 40% of mice given both protective treatments survived 2104 Rad, compared with only 14% given nitrogen alone at this dose. Dose reduction factors obtained for these mice were 2.8 for nitrogen and cysteamine together, 1.5 for cysteamine and 2.2 for nitrogen. Mice receiving cysteamine succumbed much less often to nitrogen exposure; 9.3% of anesthetized mice failed to recover after breathing nitrogen, while only 0.8% died immediately after breathing nitrogen for the same period after cysteamine injection. Although a combination of nitrogen hypoxia and cysteamine treatment provided the greatest degree of protection against whole-body irradiation, in no case was a protective factor of more than 3 obtained, even though factors of 3.1 and 3.2 were tested for. It is not therefore possible to state whether the increased protection shown with cysteamine and nitrogen hypoxia combined was due to an independent, but minor, protective effect of cysteamine operating in the hypoxic animal, or to cysteamine rendering a hypoxic animal more nearly anoxic, and thus effectively increasing the degree of nitrogen protection. Some of the present findings do not support the hypothesis that a lowering of tissue oxygen tension is the effective factor in cysteamine protection; thus the anesthetized mice given cysteamine looked pink in appearance and also withstood near-lethal exposures to nitrogen better than mice given Nembutal only. If cysteamine were lowering intracellular oxygen tension then it would be expected that the mice would be more susceptible to nitrogen hypoxia. One hypothetical explanation of this effect would be a cysteamine-induced shift of the O_2 dissociation curve of mouse oxyhemoglobin. (BBB)

7192 RELATIONSHIP BETWEEN CHEMICAL STRUCTURE AND THE EXTENT OF PROTECTION AGAINST IONIZING RADIATION GIVEN BY ALCOHOLS TO SALMONELLA TYPHIMURIUM LT2. A. B. Sidle (Medical Research Council Unit, Royal Coll. of Surgeons, London). Nature, 204: 597-8(Nov. 7, 1964).

Protective effects of various alcohols against radiation injury to Salmonella typhimurium LT2 bacteria were studied. Electrons and x radiation were used in the irradiations. The alcohols tested were pentane-1,5-diol, butane-1,4-diol, butane-1,3-diol, glycerol, propane-1,2-diol, propane-1,3-diol, erythritol, ethanediol, methanol, ethanol, isopropanol, mannitol, and n-propanol. There was a regular increase of protection with increasing chain length in the case of the diols. With polyhydric and monohydric alcohols, the tendency was for a decrease in protection with increasing chain length. The diols were a better class of protector than either the polyhydric or the monohydric alcohols. It was concluded that a balance must be struck between the hydrophilic and the lipophilic features of the molecule in order to achieve optimum protection. (M.C.G.)

7193 EARLY LYMPHATIC REGENERATION IN THYMECTOMIZED RADIATION CHIMERAS. H. Balner and H. Dersjant (TNO, Rijswijk, Netherlands). Nature, 204: 941-2(Dec. 5, 1964).

The fate of injected donor marrow was examined in both normal and thymectomized chimeras during the early period after irradiation. Female mice were thymectomized or sham-thymectomized when 6 to 8 weeks old. Four weeks later they were lethally irradiated and 3 hr later given tritium-labeled viable isologous bone marrow cells intravenously. The recipients were killed at 3 hr and at 1, 2, 4, 6, and 8 days following irradiation and injection of labeled bone marrow. The thymectomized and sham-thymectomized mice showed identical localization, proliferation, and initial follicle formation by labeled mononuclear cells. The labeled cells generally seemed to avoid the thymus and in a few days virtually disappeared from all except the lymphatic and hemopoietic tissues. The influence of the thymus on restoration of the lymphatic system was not discernible during the first 8 days of recovery, at least not morphologically. (M.C.G.)

7194 SENSITIZATION OF ANOXIC BACTERIA TO X-RAYS BY DI-T-BUTYL NITROXIDE AND ANALOGUES. Peter T. Emmerson and P. Howard-Flanders (Yale Univ., New Haven). Nature, 204: 1005-6(Dec. 5, 1964).

Escherichia coli B/r were grown with aeration to stationary phase in nutrient broth and then diluted to approximately 2×10^6/ml in ice-cold buffered saline solution for irradiation. Anoxia was maintained by passing nitrogen over the bacterial suspension prior to, and during, irradiation. Irradiations were carried out with a mean x-ray dose rate of 5.4×10^3 rads/min. Survival curves were obtained for anoxic bacteria irradiated in the presence of di-t-butyl nitroxide (DTBN), tetramethylpentamethylene nitroxide (TMPMN), and t-butyl-2,6-dimethoxyphenyl nitroxide (TBDMPN). There was a progressive increase in sensitivity to x rays with increasing nitroxide concentration. (M.C.G.)

7195 INVESTIGATION OF A BIOLOGICAL RADIOPROTECTOR. REPORT LIX. IMPORTANCE OF RADIO-INDUCED CHANGES IN CONTENT OF METABOLIC PRODUCTS FOR SURVIVAL RATE OF RATS. Hans-Joachim Melching, Mitsuyuki Abe, and Christian Streffer (Universität, Freiburg i. B.). Strahlentherapie, 125: 352-7(Nov. 1964). (In German)

Because of changes in the metabolism of tryptophan and taurine occurring after total body irradiation, investigations were conducted in order to determine the influence of these changes on the mortality of mice caused by radiation. It was found that at certain time periods after irradiation, 4-desoxypyridoxine, an antagonist to the coenzyme pyridoxal-5-phosphate and isonicotinic acid hydrazide, an inhibitor of this coenzyme, can reduce the survival rate after whole-body irradiation. Tryptophan, DL-kynurenine, and L-kynurenine exert the same effect, while taurine, appearing in the urine in reduced amounts between the 4th and 9th day after irradiation, increased the survival rate if injected into the animals during this period of time. (auth)

7196 INVESTIGATION OF A BIOLOGICAL RADIOPROTECTOR. REPORT LX. BEHAVIOR OF TESTICULAR TISSUE OF MICE WITH SINGLE OR REPEATED LOCAL IRRADIATION WITH SEROTONIN PROTECTION. Mitsuyuki Abe and Hanns Langendorff (Universitat, Freiburg, i. B.). Strahlentherapie, 125: 358-70(Nov. 1964). (In German)

The protective effect of serotonin on the germinal epithelium of male mice was investigated histologically after a single, local irradiation with 600 and 1200 R as well as after repeated irradiation with 810 R/single dose. Serotonin was found to have the same protective effect for the radiosensitive as well as for the radioresistant cells of the spermatogenic tissue. A dose reduction factor of 2 was obtained. A favorable influence of serotonin on the initial phase of tissue regeneration of the testes is responsible for its protective ability. The time course for producing new sperm cells was the same in both animals protected by serotonin and unirradiated animals. (auth)

7197 HEMATOLOGICAL AND TOXICOLOGICAL STUDIES WITH SIMULTANEOUS USE OF X RAYS AND BAYER E 39 SOLUTION. Ruprecht Koch and Franz J. Schmutz (Universität, Freiburg i. B.). Strahlentherapie, 125: 371-82(Nov. 1962). (In German)

Ethyleniminobenzoquinone was not detoxicated by substances such as cysteamine, 1,2 di-mercapto sodium propiosulfonate, 5-mercaptopyridoxine, and serotonin. In regard to the survival rate, a greater radiation sensitivity was obtained if rats received E 39 solution prior to whole-body irradiation. Contrary to the above, no significant increase in the irradiation effect in leukocytes could be obtained if ethyleniminobenzoquinone was applied simultaneously with whole-body irradiation with doses below 100 R. (auth)

7198 INFLUENCE OF PROTECTIVE EFFECT OF AET ON DISTURBANCE OF SODIUM AND WATER BALANCE IN THE SO-CALLED GASTROINTESTINAL RADIATION SYNDROME. Zoltan B. Zseboek and Gyoezoe Petranyi, Jr. (Research Group on Radiological Medicine, Academy of Sciences, Budapest). Strahlentherapie, 125: 449-55(Nov. 1964). (In German)

It is shown that the AET compound used exhibits a significant protection against disturbances in sodium- and liquid metabolism in case of intestinal radiation death. The damage to sodium absorption from the small intestine as well as the exhaustion of the extracellular liquid space is reduced. The protective effect is larger in the latter case. The damaged regulation mechanism cannot restore such a disturbance in sodium and liquid equilibrium. (auth)

7199 RADIATION SICKNESS INDUCED BY INTERNAL IRRADIATION. E. B. Zakrzhevskii and E. I. Safronov. Voenno-Med. Zh., No. 8, 29-35(Aug. 1962). (In Russian)

An examination of data from patients and experimental animals indicated that the best therapy for patients with internal deposits of radioactive materials is a general complex therapy. The treatments mentioned include washing the mouth with pure water, inducement of vomiting, administration of enemas or laxatives, use of adsorbents, and administration of complexing agents, such as EDTA. Therapy should be started as early as possible. (IIC-M.G.)

7200 PECULIAR EFFECTS OF CERTAIN MEDICATION DURING ACUTE RADIATION SICKNESS. P. P. Saksonov, P. V. Vasil'ev, V. E. Belai, and G. T. Chernenko. Voenno-Med. Zh., No. 1, 44-50(Jan. 1963). (In Russian)

Animal experiments and clinical data on the effects of narcotics, spinal anesthesia, rectal narcosis, local anesthesia, analgesics, blood-producing stimulants, antibiotics, and vitamins during radiation sickness are reviewed. No references. (IIC-M.G.)

7201 ON THE USE OF SULFANYL AMIDES AND ANTIBIOTICS DURING AN ACUTE RADIATION SICKNESS. V. I. Barbolin. Voenno-Med. Zh., No. 1, 50-3(Jan. 1963). (In Russian)

Animal experiments and clinical data on the decrease in resistance to infection that occurs as a result of irradiation and the use of antibiotics and sulfa drugs in therapy are reviewed. No literature references are given. (IIC-M.G.)

7202 INITIAL REACTION TO WHOLE-BODY IRRADIATION AND POSSIBLE MEASURES FOR STOPPING IT. V. I. Timofeev. Voenno-Med. Zh., No. 2, 49-52(Feb. 1963). (In Russian)

In irradiated animals, the time before the appearance of symptoms depends chiefly on the radiation dose and may be minutes or hours. In dogs x-irradiated with 800 R, the appearance of vomiting was delayed considerably when the vomiting center was destroyed. Shielding the abdominal organs during irradiation prevented vomiting but head and chest shielding did not. Certain drugs also prevent or alleviate the symptoms. (IIC-M.G.)

7203 DIRECT BLOOD TRANSFUSION IN THERAPY OF ACUTE RADIATION SICKNESS. A. N. Berkutov, L. S. Korchanov, N. A. Yaroslavtseva, and D. I. Bochagova. Voenno-Med. Zh., No. 5, 27-33(May 1963). (In Russian)

Ten x-irradiated dogs given blood transfusions recovered, while 4 of the 5 controls died 9 to 29 days after irradiation. In the treated animals the body temperatures did not go above 39.5°C, but reached 40 to 42°C in the controls. The symptoms of tachycardia, disappearance of the P and T waves on the electrocardiogram, decrease in arterial pressure, and prolonged hypotension in the controls were absent or ameliorated in the treated dogs. Leukocytes were higher, phagocytic activity was greater, and formed elements were restored more rapidly in the experimental than in the controls. There was no significant difference in the complement titer. (IIC-M.G.)

Radiation Hazards and Protection

7204 (ORNL-3697(p.155-9)) DOSIMETRY APPLICATIONS. J. A. Auxier, J. S. Cheka, C. G. Conn, J. L. Ellis, F. F. Haywood, W. R. Hendee, D. R. Johnson, T. D. Jones, and J. W. Poston (Oak Ridge National Lab., Tenn.).

The emphasis of the radiation dosimetry studies was on the accumulation of human-exposure data, especially the dosimetry for the survivors of the nuclear bombings of Hiroshima and Nagasaki. Refinements were made in the free-field data and dose-distribution functions developed for typical Japanese houses. The equations were developed by a multiple regression and correlation fit to the extensive data from Operation BREN. Computed values for the shielding factor at a point in a Japanese house, using these equations, were within 6% of the experimental values from weapons tests in 50% of the cases. (auth)

7205 (ORNL-3697(p.159-64)) DOSIMETRY RESEARCH. J. H. Thorngate, M. D. Brown, W. L. Croft, D. R. Johnson, J. F. Lemontt, J. E. Parks, and P. T. Perdue (Oak Ridge National Lab., Tenn.).

Other areas of investigation included small detector research, spectrometry, instrumentation, and dosimetry for radiobiological research. Fading characteristics of metaphosphate detectors were measured, advancements were made in several types of spectrometers, energy response functions were determined for dosimetry systems, and accurate dose-conversion factors were determined for PuBe and PoBe sources. (auth)

7206 (ORNL-3697(p.173-7)) INTERNAL DOSE ESTIMATION. (Oak Ridge National Lab., Tenn.).

The retention of HTO by an employee exposed in the course of his work is studied. The retention is closely approximated by the sum of two exponentials, one showing an elimination half-time of about 9 days and the other about 37 days. Although multiexponential retention functions were observed in animals, this is the first direct observation of such a retention in man; however, indirect evidence was reported. (auth)

7207 (ORNL-3697(p.199-202)) STUDIES ON THE INTERNAL EXPOSURE/EXTERNAL EXPOSURE EQUIVALENCE RELATION. S. R. Bernard (Oak Ridge National Lab., Tenn.).

A second study is reported which suggests a possible method of relating effects due to an internal source with effects due to external radiation. In effect, this amounts to a method for interspecies extrapolation at low levels of exposure. (auth)

7208 (ORNL-3697(p.202-6)) COMMENTS ON INTAKE GUIDES FOR VARIOUS ISOTOPES AND ISOTOPIC MIXTURES OF URANIUM. Mary R. Ford (Oak Ridge National Lab., Tenn.).

In the application of maximum permissible concentration (MPC) values for uranium as provided by NCRP and ICRP, questions arise concerning a curie of natural uranium. Other questions relate to the fact that limiting values for some of the isotopes are based on considerations of chemical toxicity, while for other isotopes it is the radiological hazard that is limiting; thus uncertainties in the computation of values for mixtures of the isotopes are encountered. In this study simple formulas, additional MPC values, and explanations are given as an aid in resolving these and other similar problems. (auth)

7209 (ORNL-3697(p.207-9)) ON THE ESTIMATION OF A SYSTEMIC BODY BURDEN OF PLUTONIUM. W. S. Snyder (Oak Ridge National Lab., Tenn.).

The validity of a computer program for estimating the intake and body burden of ^{239}Pu on the basis of urinary excretion is studied. One study uses data on an employee who had a long record of exposure to ^{239}Pu. From the urinary excretion data, an intake pattern and retention are estimated and compared with autopsy estimates of the tissue burdens. The study suggests that the metabolic model is not inconsistent with the data, but certain parameters of the model may be rather different for this individual. The second study uses data on dogs given Pu-nitrate by intravenous injection and by inhalation. The program seems to predict a qualitatively plausible pattern of intake to blood, and the estimates of lung deposition obtained by the code are within a factor of 2 of the estimates by the experimenters. (auth)

7210 (ORNL-3697(p.213-22)) AEROSOL PHYSICS. B. R. Fish, G. W. Royster, Jr., J. L. Thompson, R. L. Walker, W. H. Wilkie, Jr., F. G. Karioris, Georg Herrmann, Liliana Masironi, and C. F. Parrish (Oak Ridge National Lab., Tenn.).

Surface contamination measurement techniques were used in a study of particle resuspension in a room. Three tests using 3.1-μ-diam ZnS (fluorescence) and one test using 2-μ CuO (neutron activation analysis) indicate that a person working in the room is likely to inhale 1 particle/hr for every 2900 (CuO) to 5600 (ZnS) particles per square meter of surface. Agglomerates of submicroscopic thorium dioxide particles, produced by exploding thorium metal wires, were allowed to settle on a stainless steel surface. The settled aggregates were approximately 1 to 10 μ in diameter. Laboratory-scale studies show that these agglomerates can be redispersed by air jets, mechanical abrasion, and adhesion to contacting surfaces; however, the redispersion efficiencies are lower than those observed for 1.5- and 5-μ-diam solid ThO_2 particles. The question of what happens physically just prior to, during, and after a particle is reentrained in an airstream is being studied with the use of a small wind tunnel. The dynamics of the particles moving on the surface are observed by microphotography using a pulsed light beam. There is an indication that the mechanisms involved in moving particles along the surface contribute a time-dependent factor to the redispersion of particles in an airstream. Basic interactions between particles and surfaces, which determine the scale of forces required for resuspension, are being studied by applying known forces to remove particles from various surfaces. Borosilicate glass beads (28.9 μ, CMD), dispersed by settling on quartz surfaces, are subjected to known removal forces by vibrating the test surface. Well-dispersed gold aerosols with reproducible mass density can be produced by the electrical explosion of gold wires. The aerosol yield is observed to depend on the wire length, wire diameter, and voltage used for explosion. In other tests, gold and platinum wires were twisted together and exploded simultaneously by the electrical discharge. Particulate matter collected from the aerosol produced by such explosions consists of alloys of Au–Pt, giving some indication that metallic vapors were produced which mixed homogeneously. (auth)

7211 THE SIGNIFICANCE OF URINE URANIUM EXCRETION DATA. Morton Lippmann (Del Electronics Corp., Mount Vernon, N. Y.), Long D. Y. Ong, and William B. Harris. Am. Ind. Hyg. Assoc. J., 25: 43-54(Jan.-Feb. 1964).

Urine uranium excretion data for persons exposed to uranium by inhalation are analyzed. Data from both chronic and single massive exposures are included, and a generalized excretion pattern, applicable to any uranium compound absorbed by inhalation, is proposed. With this model, estimates can be made of previous exposure levels, future excretion values, and body burdens, based on appropriate urine data. It is shown that routine urine samples cannot be used to monitor individual exposures or to determine chronic exposure levels. A suitably designed series of samples, collected after the termination of exposure, however, can provide useful estimates of exposure level and body burden. (Public Health Eng. Abstr., 44: No. 10, Oct. 1964)

7212 REDUCTION OF RADIATION TO CHILDREN. Forrest H. Adams and Leo G. Rigler (Univ. of California, Los Angeles). Circulation, 30: 160-2(Aug. 1964).

Means for reducing the radiation exposure of children in diagnostic radiology are considered. It is essential to use optimal instrumentation and technics for infants and children. Leak-free tube housing, appropriate filtration, rectangular coning, shielding, modern film screens, and processing technics are important. The radiation dose to the patient undergoing a routine heart x-ray examination can be reduced significantly by using optimal equipment and exposure factors. It is pointed out that many physicians routinely use fluoroscopy rather than radiography in the evaluation of the cardiac patient, but fluoroscopy has the major disadvantages of rendering a much greater radiation dose to the patient, of requiring a minimum of 10 min for dark adaptation, and of providing no permanent record for future study. Conventional fluoroscopy even in the hands of an experienced radiologist will deliver a radiation dose that is 10 to 1000 times that delivered by a film of the same area. The use of an image-intensifying unit will reduce this fourfold. If fluoroscopy is to be used, it should be used with an image-intensifying unit and a timer to monitor the total exposure. Radiation exposure records should be maintained for each patient, particularly those requiring long-term follow-up. Methods for reducing the radiation dose to infants and children are as follows: (1) Give special consideration to the indications for radiologic examination. (2) Make better use of other clinical modalities such as the electrocardiogram, vector-cardiogram, and phonocardiogram. (3) Restrict fluoroscopic examinations to the most complicated lesions. (4) Use an image-intensifying unit for fluoroscopy where possible. (5) Monitor radiation exposure with timing devices. (6) Use the optimal exposure factors that reduce radiation exposure to a minimum. (7) Use gonadal protection devices during radiation. (8) Use optimal filtration and coning of x-ray beams. (9) Use the best sensitive screens, films, and processing solutions. (10) Use rapidly excreted isotopes with low activity and short half life. (11) Make yearly checks on radiation output of equipment. (BBB)

7213 REVISION OF X-RAY TECHNIQUES AND SUGGESTIONS IN VIEW OF POSSIBLE GONAD DAMAGE. II. HOW TO REDUCE GENETIC DAMAGE TO THE POPULATION. Zoltán Hrabovsky and István Nikl. Magy. Radiol., 16: 195-209(Aug. 1964). (In Hungarian)

A detailed survey was made of the precautionary measures necessary to decrease the radiation dose to the population that could have harmful genetic effects. Positive action should be taken by radiologists, clinical physicians, and health authorities, as well as by the x-ray industry. More sensitive film will permit lower doses and therefore less possibility of genetic damage. A table shows the doses necessary with films of different grades and sensitivities. It is important that the diaphragm be a tight fitting one and be kept closed when the apparatus is not in actual use. The gonad dose received with open and narrow diaphragm is given as follows: chest x-ray, open diaphragm 6 mrem, narrow 0.04 mrem; pelvic spine, 2100, 65; thigh, 600, 1. The

requirement for somewhat underexposed and overdeveloped x-ray pictures is stressed. It is recommended that conventional radiologic examinations be conducted with a 3-mm Al filter, or a 5-mm Al filter for the hard-radiation technique, also 0.2- to 0.3-mm Cu filtration in the tube are recommended. For radioscopy 100-kv alternating current and 80 to 90-kv direct current with a 6- to 7-mm Al filter is recommended. Unnecessary x-ray surveys of entire segments of the population, particularly school children, is condemned. This only provides an additional radiation hazard. It is recommended that if a person is x rayed, he should receive a permanent record of that fact and should only be examined again if there is a definite medically warranted need. A great burden lies on the general practitioner in preventing the prescribing of unnecessary x-ray examinations. Small children should only be x rayed if their illness cannot otherwise be determined or cured. A plea is made to the x-ray industry to supply hard technique apparatus in sufficient quantity, with built-in filters (3- to 4-mm Al, 0.2- to 0.3-mm Cu + 1-mm Al), with depth diaphragms, and proper gonad-protecting shields, and to improve shielding equipment and devise new and better methods of radiography. The local health authorities should limit x-ray examinations to only those essentially required. (BBB)

7214 THE EFFECT OF RADIOPROTECTIVE SUBSTANCES ON THE PHAGE PRODUCTION OF LYSOGENIC BACTERIA, INDUCED BY IRRADIATION WITH X-RAYS. N. N. Zhukov-Verezhnikov, I. N. Maiskii, A. P. Pekhov, N. I. Rybakov, P. P. Saksonov, B. A. Mishchenko, V. A. Kozlov, K. D. Rybakova, and E. D. Aniskin (Inst. of Experimental Biology, Moscow). Radiobiologiya, 4: 738-42(1964). (In Russian)

Lysogenic bacteria, which can react readily to the action of ionizing radiation by an increase in phage production, can be used as a model in testing the protective effect of various substances towards genetic damage. The criterion for the effectiveness of the radioprotective action of mercamine disulfide (cystamine), 2-mercaptopropylamine, and uretane was the dose lowering factor (DLF), which is the ratio of the irradiation dose resulting in a definite level of phage production with the presence of the protective agent to the dose resulting in the same level of phage production in the absence of the protective agent. The time of contact of the lysogenic bacteria with the protective agent before the irradiation has an effect on the number of phage-producing bacteria induced by the radiation. Thus, the maximum decrease in phage-producing bacteria induced in E. coli K_{12} (λ) with an x-ray dose of 15 kR was observed after a two-hour contact with cystamine. The behavior of 2-mercaptopropylamine was analogous to cystamine, but uretane showed no radioprotective effect on lysogenic bacteria. This method can be used as an express method in selecting chemical compounds having a protective effect against radiation damage of a genetic character. (TTT).

7215 MECHANISM OF RADIATION-PROTECTION ACTION OF o-, m-, AND p-AMINOPROPIOPHENONES. E. F. Romantsev and N. I. Bicheikina (Inst. of Biology and Physics, Moscow). Radiobiologiya, 4: 743-5(1964). (In Russian)

In order to determine whether the radioprotective action of o-, m-, and p-aminopropiophenone (o-APP, m-APP, p-APP) is related to their ability to form methemoglobin (MetHb), male white rats (200 to 220 g) were given the compounds intraperitoneally in propylene glycol solution and irradiated (^{60}Co) to 750 R ($LD_{95-100/30}$) at 334 R/min. Determinations of MetHb in the blood 10 and 20 min after the compounds were given showed an approximate linear increase, to 14 and 31%, respectively, in animals given p-APP (30 mg/kg). Those given propylene glycol (0.5 ml/200 g), o-APP (100 mg/kg) or m-APP (100 mg/kg) showed no MetHb in the blood. However, 30-day survival rates of animals irradiated 17 to 20 min after administration of o-APP, m-APP, and p-APP were 33, 50, and 81%, respectively, compared to 6% in the nonirradiated controls. p-APP showed a much lower protective effect on animals irradiated 60 min after administration of the drug, although the blood MetHb was still 28% at that time. The results proved that the mechanism of the prophylactic action is not related to tissue hypoxia. The formation of MetHb in the blood of the rat after administration of p-APP does not appear to be a deciding factor in its prophylactic action. (TTT)

7216 MECHANISM OF ACTION OF SOME RADIATION-PROTECTIVE PREPARATIONS ON THE INTRAUTERINE DEVELOPMENT OF THE RAT. N. A. Kalinina (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 4: 746-51(1964). (In Russian)

Radiation protection of the fetus by preparations given to the mother was studied in white rats, which were irradiated on the 11th day of pregnancy with doses of 200 or 300 R at 30 to 35 R/min. Intramuscular injections of phenatine (0.1 mg/kg), aminazine (10 mg/kg), and mercamine (75 mg/kg) were given 15 to 30 min before irradiation and magnesium sulfate (400 mg/kg) 5 min before. With 200 R irradiation, no significant protective effect was shown by phenatine or aminazine. However, with 300 R, all compounds tested decreased the loss of fetuses and somewhat decreased the percentage of developmental anomalies, which occur as a result of irradiation. Mercamine gave the best protection. Depression of the fetal breathing center on the seventh day after irradiation was less in animals given mercamine before irradiation than in the untreated. Further recovery of the excitability to normal was like that in the unprotected. Treatment with magnesium sulfate seven days after irradiation did not decrease the depression, but recovery was faster in these animals. The number of fetuses examined was 1680. (TTT)

7217 COMBINED CHEMICAL PROTECTION IN ACUTE RADIATION SICKNESS. V. V. Petelina (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 4: 752-5(1964). (In Russian)

The combined effect of aminazine and phenatine on radiation sickness was studied in seventy dogs irradiated to 500 or 600 R at 12 to 14 R/min. Intramuscular injections of aqueous solutions of the compounds (0.5 mg/kg) 30 min before irradiation ameliorated the radiation effects, particularly with the higher radiation dose. In the protected animals symptoms of damage to the gastrointestinal tract appeared less and leukocyte, thrombocyte, and erythrocyte levels were higher for the 44-day observation period than in the controls. An increased erythrocyte sedimentation rate occurred earlier in the controls than in the protected animals. Of 40 dogs irradiated to 600 R, 35% of the treated and 65% of the controls died; the average lives were 35 and 22 days, respectively. Examination of tissue sections showed the hemorrhagic syndrome picture and damage in the intestinal tract. Some of the controls showed necrotic angina. (TTT)

7218 RADIATION HAZARDS IN SPACE. David L. Dye and Maurice Wilkinson (Boeing Co., Seattle). Science, 147: 19-25(Jan. 1, 1965).

A statistical approach to radiation doses in various body regions in space is presented. The results of calculations of the amount of radiation from protons trapped in the earth's magnetic field or emitted in solar flares that is absorbed at various points in the body of a human being seated in a spherical-shell vehicle, the body tissues themselves being considered part of the shielding, are included. The data are gathered in order to clarify the nature of the hazard and to quantify the hazard on the basis of some reasonable assumptions. General procedures to be followed in planning to minimize radiation hazard in a manned space mission are listed. (P.C.H.)

7219 PROTECTION AGAINST GAMMA-RADIATION DURING CALIBRATION OF DOSIMETRIC DEVICES. N. S. Sobol. Voenno-Med. Zh., No. 12, 36-7(Dec. 1962). (In Russian)

Calibrations are carried out in closed cells with up to 70-cm-thick brick walls. The source, which is located in a metal tube inserted 2.5 to 3 m in the front wall, is removed only when in use. The dosimeter is introduced through an opening that is covered outside with lead glass. A periscope is provided for observations. The door into the chamber is screened. (IIC-M.G.)

7220 PROTECTION AGAINST IONIZING RADIATIONS. A Survey of Existing Legislation. Geneva, World Health Organization, 1964. 170p.

This comparative survey of health legislation on radiation protection is based on such source material as was available at the Headquarters of the World Health Organization to June 1964. It is not intended to provide an exhaustive coverage of world legislation in the field in question, but to give typical examples from 26 countries of the form that such legislation has taken. As far as radiation protection is concerned, it is pointed out that the legislation is in a state of rapid development and that changes are frequently being made; for this reason, it is possible that, in certain respects, the survey may not be completely up to date. (auth)

Radiotherapy and Radiodiagnosis

Refer also to abstract 7666.

7221 (ORNL-P-750) NEW CHALLENGES IN CLINICAL COUNTING. D. A. Ross, C. C. Harris, M. M. Satterfield, and P. R. Bell (Oak Ridge National Lab., Tenn.). [1964]. Contract W-7405-eng-26. 20p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

In the field of nuclear medicine the value of the pulse-height spectrometer is now well recognized. Given an alert and informed operator, it can reduce the obscuring effects of background; it can at least partially suppress unwanted scattered radiation; it can provide better stability (other things being equal) than is available in a threshold counter; it can check the radiochemical purity of a questionable drug; and often it can measure separately two radioactive components in the same sample. The persistent clamor for still lower radiation doses to the patients, and the development of new, low-energy emitters, make new demands on the counting equipment, and skillful operation is more important than ever. Good counting efficiency is hard to obtain, and the factors that determine it should be well understood if weak samples are to be counted. The selection of the spectrometer's energy band depends on resolution, as well as on other things. The counting of large, weak samples, and of whole patients, brings up a number of difficult problems, and calls for an all-out attack on background. The low-energy radionuclides are focusing renewed attention on the problems resulting from absorption and scattering, and special techniques may be needed. Medical uses of moderate and low-energy radioisotopes including gold-199 and iodine-123 (159 kev), cerium-141 (145), technetium-99m (140), cobalt-57 (122), xenon-133 (81), mercury-197 (67-78), cesium-131 (30), and iodine-125 (28 kev), and problems in counting presented by their use, are discussed. (C.H.)

7222 THE PHYSICAL AND BIOLOGICAL BASES FOR FAST-NEUTRON BEAM CANCER RADIOTHERAPY. J. R. Andrews and R. J. Berry (National Cancer Inst., Bethesda, Md.). Acta Unio Intern. Contra Cancrum, 20: 1202-4 (1964).

The physical, radiobiological, and clinical aspects of fast neutron beam irradiation are discussed. (P.C.H.)

7223 APPARATUS AND METHODS FOR IMPROVED OBSTETRIC ROENTGEN DIAGNOSIS. Carl-Erik Unnerus (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenniae, 53: 218-22(1964).

For an improved absorption factor in soft-part diagnosis of the pregnant uterus, an aluminum wedge, suitable for all abdominal shapes, was devised. Interest in the reduction of the radiation dose led to its development. This light, simple filter, which is illustrated, is placed immediately against the deep diaphragm device which is now incorporated in most x-ray tubes. This wedge can be moved in relation to the focus of the tube and can therefore, depending on the shape of the abdomen, be positioned so that it moves further in toward the center of the picture or remains nearer the edge. This device can be used with equal facility for any rounded part of the body to provide more even absorption of radiation such as in the back or extremities. This relatively small aluminum filter does not absorb the harder rays to any appreciable extent. However, it is capable of reducing the softer rays by an average of nearly 15%. Thus it is valuable in obstetric roentgenology for reducing the radiation dose. Also described are an improved abdomen compressor and an apparatus for calligraphy which is adapted to the arm of the x-ray tube. With these accessory factors and improved examination apparatus it was possible to: (1) reduce the radiation doses, (2) obtain even blackening on the roentgenograms, whereby it became possible to visualize: (a) the fetal skeleton and especially the thin bone centers, (b) the placenta, (c) the wall of the uterus; (3) measure the pelvis accurately in the most important directions. This, with very small radiation doses, makes it possible to provide roentgenologically important information to the obstetrician very rapidly without complicated methods of calculation. (BBB)

7224 MODERN THEORETICAL AND PRACTICAL CONSIDERATIONS IN REGARD TO SYSTEMATIC RADIOLOGICAL EXAMINATIONS. Roland Buchet (Hopital Bichat, Paris), J. Aussage, Gérald Valeri, and A. Bellin. Ann. Radiol., 7: R675-92(1964). (In French)

The techniques, advantages, disadvantages, and applications of systematic radiological examinations in the diagnosis of diseases of the lungs are discussed. Some of the methods discussed include teleradiography, radioscopy, radiophotography, direct radiography on paper, and radioelectronic procedures such as televised radioscopy with or without magnetic registration of the images. Factors used in evaluating the methods include: clinical, therapeutic, and prophylactic uses; social reverberation; the limited character of the medical and financial returns; and administered doses. (P.C.H.)

7225 MODERN TRENDS IN THE TREATMENT OF UTERINE CARCINOMA. H.-L. Kottmeier (Radiumhemmet, Stockholm). Arquiv. Patol. (Lisbon), 36: 47-64(Apr.-July 1964).

The advantages of radiation treatment over surgery, radiosensitivity data, and techniques of radiotherapy, as applied to patients with preinvasive (in situ) cervical carcinoma, are described. Precautions in the use of radiation are outlined, dosimetry factors are considered, and injurious sequelae of irradiation are described. Invasive carcinoma was diagnosed in 47 out of 248 cases of carcinoma in situ; after a full course of radiotherapy, a complete cure was effected in all 47 cases. In the great majority of cases involving carcinoma of the cervix, the use of irradiation is preferable to surgery for the following reasons: (1) radiotherapy is simpler and can be used in all cases; (2) recovery is far quicker; (3) results are somewhat more successful; and (4) injury from irradiation in operable cases is unusual, while fistulas sometimes occur following radical surgery. In most cases the combined use of intracavitary and external irradiation is necessary. Only in very early lesions should the radiotherapy be restricted to Ra application to the uterus, but occasionally it is feasible to administer only external irradiation. Treatment should be administered only in well-equipped institutions, with the gynecologist, radiotherapist, and health physicist working in close collaboration. Since the function of radiotherapy is to administer a damaging dose to the tumor and to keep the dose affecting healthy tissue at a minimum, three important factors must be taken into consideration: (1) the inverse-square law, (2) the time-dose relation, and (3) the volume-dose relation. The radiotherapist should be familiar with the various types of applicators and their isodose curves and should be aware of the possibility of changing the loading of applicators. The standard Radiumhemmet (Stockholm) method of treating cancer of the cervix with radiation consists of two Ra applications of about the same dosage and spaced three weeks apart. The filtration is equivalent to 2 to 3 mm of lead. Intrauterine applicators are loaded with 53 to 70 mg of Ra over a tube of length 43 to 75 mm. A dose

of about 75 r/hr is delivered 2 cm from the center of the tube. From 65 to 75 mg Ra are applied to the vagina, none of which is applied in the lower 2 cm of the cervical canal; it is important to distribute diffusely the vaginal Ra sources in applicators as large as possible. Intrauterine and intravaginal Ra application should not be made simultaneously where infection is present. Pyometra is not a contraindication to the insertion of Ra, but in cases complicated by salpingitis, removal of the adnexa is indicated, the pelvis should be drained and irradiation postponed until one week after laparotomy. A 65.9% rate of cure over a five-yr period was attained in 47 cases treated in this manner as opposed to a rate of 14.4% in 118 similar cases treated conservatively. Times of application of intrauterine and intravaginal Ra sources should vary with the intensity of radiation. In the standard Stockholm system, two insertions of high intensity are given three weeks apart which permits normal cells to recover while malignant cells remain damaged. The maximum level of degenerative changes in the nonmalignant epithelial cells is reached within 12 to 18 days following the first Ra insertion. Direct reading measurement is the most accurate method of determining the dosage to be used in individual cases. After application of the Ra, a Siemens gamma-meter with a small ionization chamber mounted on a curved probe is inserted first into the bladder and then into the rectum. The patient is anesthetized and in the lithotomy position measurements are recorded for 1 cm intervals along the posterior wall of the bladder and the anterior wall of the rectum, which measurements, if correlated with anterior-posterior and lateral x-ray films, provide information on the position of the Ra. From a series of 500 consecutive patients with carcinoma of the curvix investigated in regard to the appearance of rectal and bladder injuries, it is considered that 4000 r is an optimal dose in the rectum and 5000 r in the bladder with the Stockholm method. Rectal injuries in relation to the dosage measured in the rectum were as follows: 0 to 1999 r 4.3%, 2000 to 2999 r 4.3%, 3000 to 3999 r 9.8%, 4000 to 4999 r 14.0%, 5000 to 5999 r 21.0%, 6000 and over 21.0%. Complications from therapy are described. Injuries to the bladder appeared in 6 cases, to the rectum in 14. A fistula occurred in four of these 20 cases. The total number of injuries amounted to 4.9%. In addition to these injuries, slight Ra reactions were seen in 33 cases in the rectum and in 17 in the bladder. (BBB)

7226 MECHANISMS OF RADIATION CARCINOGENESIS AT THE CLINICAL LEVEL. J. I. Fabrikant (Inst. of Cancer Research, Belmont, Surrey, Eng.), R. J. Dickson, and B. F. Fetter. Brit. J. Cancer, 18: 459-77(Sept. 1964).

The case histories of 6 patients in whom cancer was induced as a consequence of radiation exposure made to treat a benign or malignant neoplasm or to establish a radiological diagnosis following internal administration of a radioactive contrast material (thorotrast) are reviewed. In order to assess the importance of the direct and indirect effects of radiation, relevant data on dose and dose rates, latent periods, extent of tissue damage, and types of tumors induced are included. The data are discussed in terms of possible mechanisms of radiation carcinogenesis at the clinical level to provide additional information concerning the risks of diagnostic and therapeutic radiation exposure. (P.C.H.)

7227 X-RADIOGRAPHY WITH MERCURY 197. B. Herszberg, Y. Bresson, and C. Kellershohn (Faculté de Médecine, Paris). Brit. J. Radiol., 37: 928-37(Dec. 1964).

After briefly recalling the essential outlines of the work done so far towards practicable medical radiography with radioactive sources, attention is drawn to the value of the nuclear characteristics of ^{197}Hg in this field. The manufacture of a source consisting of a 0.5 mm bead of mercury is described. The source is sufficiently intense for human radiography with acceptable exposure times. A number of in vivo radiographs are presented to illustrate the potential of the device and method, particularly in cranial radiography by means of a source placed in the mouth. The relative merits of ^{197}Hg and other radioisotopes (particularly ^{125}I) are discussed. Finally, the possible future improvement of the ^{197}Hg radiography technique described is indicated. (auth)

7228 NEUTRON RADIOGRAPHY IN MAN. J. Anderson (King's Coll. Hospital, London), S. B. Osborn, R. W. S. Tomlinson, and J. W. Smith. Brit. J. Radiol., 37: 957-8 (Dec. 1964).

The use and advantages of neutron radiography in man are discussed. It was concluded that neutron radiography may be of value in studying air cavities covered by bone if a sufficiently powerful source of neutrons is available to reduce exposure times and still give adequate film response. (P.C.H.)

7229 HALF-VALUE THICKNESS EQUIVALENTS IN WATER. W. S. B. Lowry (Northern Ireland Radiotherapy Centre, Belfast). Brit. J. Radiol., 37: 958(Dec. 1964).

A graph was compiled in which half-value thicknesses (HVT) in different metals can be compared with their equivalents in water. It is noted that with increasing energies lead becomes a less satisfactory material for HVT specification. (P.C.H.)

7230 FUNCTIONAL RESULTS AFTER X-RAY AND Ra IRRADIATION OF LARYNGEAL CARCINOMAS. Wolfgang Pfau (Universität Halle/Saale, Ger.). HNO, 10: 111-13(Apr. 1962). (In German)

X ray or Ra treatment are the most frequently used and most successful methods for treatment of carcinoma of the vocal cords. Radiation treatment does not cause any great damage to vocal function. In the 57 patients studied in this investigation, function of the vocal organs and voice quality were measured. Of these, 47 were treated with Ra implants, 9 were x irradiated, and one was initially treated with Ra and later irradiated with x ray because of recurrence of the tumor. From the observations made on these patients it appeared that the treatments not only destroyed the tumors, but also in most cases resulted in return of satisfactory vocal function. This was established by affirmations of the patients, and separately by vocal tests. Frequent, deeply probing incisions can bring about severely cicatrized changes in the vocal cords, and thus lead to irreparable injuries to the voice. This may place some individuals who require a clear voice in their occupation at a disadvantage. For this reason incisions should be carried out very carefully, especially in patients who may be given radiation treatment later. If the vocal cords are damaged, a false voice pouch can be formed. In these cases it is very desirable to train the patient by appropriate vocal exercises to develop a voice suitable for everyday speech. (BBB)

7231 DIAGNOSTIC NUCLEAR MEDICINE. Leonard Rosenthall (Montreal General Hospital). J. Can. Assoc. Radiologists, 15: 46-7(June 1964).

Recent developments in the use of radioisotopes in diagnostic tests are discussed briefly with emphasis on some of the problems encountered in providing necessary facilities in small hospitals. In the past, isotope equipment was largely limited to larger centers, as the small hospital could not justify the cost for the few tests available. However, this is no longer so, and the spectrum of isotope procedures at a clinical level is now wide enough to keep the unit gainfully employed in a 150-bed hospital. This spectrum will grow as biochemists and physical chemists find new organ specific compounds and learn to tag and incorporate γ-emitting isotopes into existing compounds. It is pointed out that in Canada there is a dearth of people with specific training and interest in diagnostic nuclear medicine. Many departments are run by a group of individuals, each concerned with the test peculiar to his specialty. This generally does not permit a coordinated effort in keeping abreast of newer developments in clinical procedures or instrumentation. It is suggested that a course in nuclear medicine should be a requirement for all diplomas in radiology (which includes diagnosis and therapy) and therapeutic radiology. The initiative should be taken by the radiology departments of the larger teaching centers where facilities exist and require a minimum of three months' intensive training. The radiologists so trained

should be able to set up and direct diagnostic isotope centers in the smaller hospitals. (BBB)

7232 PRACTICAL USE OF BONE MARROW TRANSFUSION IN TREATMENT OF BLOOD DISEASES. C. T. Nicolau (Centrul de Hematologie, Bucharest). Med. Interna., 15: 1409-16(Dec. 1963). (In Rumanian)

The combined use of whole-body irradiation and bone-marrow grafting in the treatment of blood diseases is discussed. (BBB)

7233 THE DIAGNOSTIC SIGNIFICANCE OF THE ISOTOPE RENOGRAM IN UROLOGICAL DISEASES. W. Staehler, K. M. Bauer, and U. Feine (Universität, Tubingen, Ger.). Med. Welt, 15: 776-80(Apr. 13, 1963). (In German)

The radioactivity curve registered over the kidney following administration of ^{131}I labeled Hippuran suggests three phases. These are the initial rise, which corresponds to mixing of the radioactive compound with the blood, a secretory phase, and a disappearance phase, when the radioactivity curve decreases and approaches values similar to the rate of blood disappearance. The results of 1200 renogram studies in patients indicate that this test is useful in diagnosis of unilateral kidney function, excretory disturbances of various types and genesis, pyelonephritis, and renal hypertension. The use of the radioisotope renogram is supplemental to excretion urography and other x-ray procedures, and the use of clearance studies. It does not replace them. It has the advantage that it measures kidney function without extensive hazard to the patient, and can be used as a measure of urine formation or unilateral renal circulatory disturbances. It has definite clinical advantages. These are that it measures and compares unilateral kidney function, without subjecting the kidneys to large amounts of radiation. Total body radioactivity after 24 hr is essentially zero. The total radiation exposure amounts to ~1% of that which results from excretion urography. Impaired kidney function with retention of substances that are eliminated normally through the kidney does not contraindicate a renogram study. Because it is a simple test, but does not endanger the patient, it can be used repetitively with patients to study kidney function. (BBB)

7234 IONOMETRIC AND BIOLOGICAL ASPECTS OF CONTAMINATION OF THE GAMMA BEAM IN TELECESIOTHERAPY. G. Piazza, F. Pozza, and F. Calzavara (Università, Padua). Minerva Radiol. Fisioterap. Radiobiol., 9: 385-7(Sept. 1964). (In Italian)

Dosimetric and biological studies were made on the variations of the region of the build-up dose due to electron contamination of the gamma beam of ^{137}Cs. The decontaminating capacity of various filters was established, and the effect of the interposition of one of the absorbers investigated (plexiglass) between the radiation source and the ionization chamber was examined. The variations of the surface dose were investigated as well as the variations of the dose in air. It was found that the point of greatest ionization tends to become closer to the surface when the absorber is close to the ionization chamber. Simultaneous biological studies were performed by observing the changes in the skin on the belly of rabbits. The physical and radiobiological results were found to correspond. (auth)

7235 NUCLEAR TECHNIQUES IN BIOMEDICAL RESEARCH. John H. Lawrence (Univ. of California, Berkeley). Nucleonics, 23: No. 1, 48-9(Jan. 1965).

Developments in the use of radioisotopes and nuclear radiations in biomedical research and clinical problems are discussed. Tracer techniques, radioisotope distribution, radiation effects and dose, and radiotherapy are included. (P.C.H.)

7236 THE SCINTILLATION CAMERA IN DIAGNOSIS AND RESEARCH. H. O. Anger, D. C. Van Dyke, A. Gottschalk, Y. Yano, and L. R. Schaer (Univ. of California, Berkeley). Nucleonics, 23: No. 1, 57-62(Jan. 1965).

The use of short-lived isotopes, such as ^{18}F, ^{52}Fe, and ^{99m}Tc with a scintillation camera in diagnosis and research is discussed. Advantages of the scintillation camera in such work are listed. The uses of the scintillation camera for liver studies, stop-motion scintiphotography of kidneys, brain tumor studies, stop-motion scintiphotography of heart, and thyroid and bone surveys in humans and for studies of tagged agents in animals are described. (P.C.H.)

7237 RADICAL HYSTERECTOMY VERSUS RADIOTHERAPY IN STAGE I CERVICAL CANCER: PRELIMINARY RESULTS. Michael Newton, Bernard T. Hicman, and Karl A. Bolten (Univ. of Mississippi, Jackson). Obstet. Gynecol., 24: 564-8(Oct. 1964).

Some of the advantages and disadvantages of radiotherapy, as compared with surgery, and the resulting complications of both methods are considered with reference to 91 patients with carcinoma of the uterine cervix. External ^{60}Co teletherapy was given through two anterior and two posterior ports with a 3 cm central gap; delivery of 3255 R to point A and 3500 R to point B was attempted. Then radium was inserted by means of an Ernst applicator containing 80 mg of radium; it was usually left in place for 72 hr to give a dose of 4520 R to point A and 1610 R to point B. Thus the total dose of radiation was about 7775 R to point A and 5110 R to point B. Radiotherapy was completed within 40 days. Operative treatment consisted of radical hysterectomy, bilateral salpingo-oophorectomy, excision of the upper one-third of the vagina, and bilateral pelvic lymphadenectomy from near the bifurcation of the aorta to the inguinal ligament. Of the 91 patients studied, 43 were treated by operation and 48 by radiotherapy. The survival rate without known recurrence was 67% for the surgical group and 75% for the radiotherapy group, but statistically significant differences were found between the two groups; 69% of 36 patients treated by surgery and the same percentage of 36 patients treated by radiotherapy are known to be alive and well without evidence of recurrence two years or more after the end of treatment. Up to the present time slightly more complications (especially of the urinary tract) occurred in the patients treated by operation. After radiotherapy two complications involved the intestinal tract, one consisting of severe nausea and vomiting which caused prolonged interruption of therapy and another of radiation proctitis. Six had vaginal complications which included one with severe bleeding before and during radiotherapy and five with marked radiation reaction in the vagina which required considerable medical attention following therapy. The absence of major urinary-tract complications in the radiotherapy series was notable. Data on complications are still incomplete but suggest that in the early years of the study somewhat more complications have occurred in the surgical series and that most were related to the urinary tract. However, almost all patients, both those receiving surgical treatment and those receiving radiotherapy, were adequately rehabilitated within two years and usually within 12 months. (BBB)

7238 CALIBRATION OF COBALT-60 TELETHERAPY MACHINES USING BENZENE-IN-WATER DOSIMETERS. Jose O. Juliano and Gloria R. Capco (Philippine Atomic Energy Commission, Manila). Philippine J. Sci., 92: 441-5 (Dec. 1963).

The procedure for use of benzene-in-water dosimeters in calibration of ^{60}Co teletherapy machines is presented. It is noted that this dosimeter gives consistent results and is stable for long times before and after irradiation. (J.R.D.)

7239 INFLUENCE OF COLLIMATOR DESIGN, PHOTON ENERGY AND RADIATION DOSE ON DETECTION EFFECTIVENESS IN LIVER SCANNING. David E. Kuhl (Univ. of Pennsylvania, Philadelphia). Phys. Med. Biol., 10: 93-105(1965).

An experimental test was made of four different focused lead collimators with a phantom to represent the liver containing a solid non-radioactive tumor void positioned at different depths. Six different radionuclides were used with photon energies ranging from 30 to 412 kev. To explore the influence of collimator design and photon energy, a figure of merit Q/ρ was used as an index of detection effectiveness. The best Q/ρ was found using 158 kev photons and the lower energy collimator with a 3 in. focal length. A second figure of merit, Q/D, which was normal-

ized to unit absorbed liver dose, was used as an index of detection effectiveness when radiation dose to the patient was considered as the significant parameter. Of four compounds used in liver scanning, the most effective agent was found to be ^{99m}Tc colloid. The analysis showed that a marked improvement in liver scanning data should result from the use of large milliCurie amounts of radionuclides with physical characteristics that keep the liver dose low. A smaller, but still substantial, improvement should result if the photon energy is chosen to be in the 150 kev range and a collimator is used that is appropriately designed for lower energy radiation. (auth)

7240 CHARTS FOR Co-60 TELETHERAPY OF TREATMENT TIME FOR 100 r TUMOR DOSE AND "SKIN" DOSE FOR 100 r TUMOR DOSE. Lillian E. Jacobson (United Hospitals of Newark, N. J.). Radiazioni Alta Energia, 3: 169-78(July 1964).

Treatment time and skin dosage charts for different field sizes are given for 80, 50, and 100 cm source skin distances. The skin dose remains the same for all machines for the given S.S.D., depth, and field size. A treatment time chart for rotation therapy is given in which the time for 100 R is listed versus the average thickness of a patient for different field sizes. This chart is applicable for source axis distances from 40 to 100 cm. A table is given for use with opposing port therapy at 55 cm S.A.D. The time to treat each port, for 100 R tumor dose, and the skin dose including exit dose are charted versus the thickness of the patient for different field sizes. A method is described for calculating the treatment times for any cobalt-60 therapy machine from the given tables. (auth)

7241 RADIOTHERAPY OF BLADDER TUMORS WITH TELECOBALT THERAPY AND WITH X-RAY GRID IRRADIATION. Gy. Gyenes (National Oncological Inst., Budapest). Radiobiol. Radiotherap., 3: 579-84(1962). (In German)

Of a total of 48 patients 25 were treated with 180-kv x ray, using a 50% grid. The daily dose was 700 R, and the total radiation given was between 7000 and 10000 R to each of two fields. Telecobalt irradiation was given to 23 patients. They were irradiated ventrally and dorsally. The daily individual fractions were 150 Rad, and the total dosage varied with the patient's condition, amounting to at least 3000 Rad. The highest dosages were 4000 to 5000 Rad. All radiation was well tolerated when 1 g of streptomycin also was given daily. The irradiations were given five times weekly on consecutive days. Most of the tumors were located laterally, or were multiple and diffusely distributed. A few were located on the dorsal bladder wall or the trigonum vesicae. Relatively, the best results were obtained with the higher radiation doses of x ray or telecobalt irradiation. In the cases where the telecobalt dose was less than 3000 Rad there was absolutely no objective improvement observed by cystoscopic examination. In two patients irradiated with less than 10000 R of grid x irradiation there was definite regression of the tumor. In 7 out of 15 patients who received less than 3000 Rad of telecobalt irradiation there was not even subjective improvement, and their hematuria was not affected. In 7 of 14 patients who received less than 10000 R of x irradiation, hematuria disappeared by the time the treatment was terminated. In 5 out of 8 patients who received more than 3000 Rad of telecobalt irradiation, and in 5 out of 11 patients who received more than 10000 R of x irradiation regression of the tumor was observed cystoscopically. Subjective improvement was reported in 18 to 25% of the patients who received the high doses of both types of irradiation. The protective effect of grid irradiation permitted proper dosage of the tumor without damage to other tissues, but telecobalt irradiation produced a more unfavorable dose distribution. (BBB)

7242 COMMENT ON RADIOACTIVE RADIOISOTOPES USED IN THE DIAGNOSIS OF SPINAL CORD TUMORS. F. M. Ljass (Burdenko Inst. for Neurosurgery, Moscow). Radiobiol. Radiotherap., 4: 219-29(1963). (In German)

General properties of radioisotopes for use in the diagnosis of spinal cord tumors are discussed. A comparison of the properties of the radioisotopes Rn and ^{133}Xe indicated that of the two ^{133}Xe is superior to Rn for diagnosis of tumors of the spinal medulla. This finding is based on the following reasons. The amount of radiation energy absorbed within the subarachnoid space is nearly 150 times less from ^{133}Xe than it is from the same amount of Rn, the amount of radiation energy absorbed by the lungs from Rn in the vascular system is close to 160 times as much as that from ^{133}Xe, and ^{133}Xe has no long lived daughters, nor does it emit α particles. (TCO)

7243 THE DIAGNOSIS OF BRAIN TUMORS WITH THE AID OF RADIOISOTOPES. (PHANTOM EXPERIMENTS AND RESULTS OF STUDIES IN 100 PATIENTS). V. Kvicala and J. Boucek (Charles Univ., Prague). Radiol. Diagn., 4: 107-16(1963). (In German)

Radioiodinated human serum albumin was used for diagnosis of brain tumors in 100 patients. Radioactivity was measured at 32 points on the skull surface. Good results were obtained in localization of meningiomas, and in 6 out of 8 cases with brain metastases. Intracerebral tumors were less accurately localized. Several peculiarities could be explained as the result of geometric factors. For example, increased radioactivity was detected frontally and occipitally, even though the tumor was located temporally. The nearer the midline that the tumor was located, the less were the lateral differences. However, in several cases a midline tumor could be detected when the radioactivity curves were compared with the normal curve. When the curve was grossly altered, and the lateral differences were small, it was suggestive of a midline tumor. Only 9 patients with tumors in the posterior cranial fossa were studied. This number was inadequate to establish adequate criteria. The procedure was to measure 12 points over the posterior fossa. In 6 cases there were significant increases of from 15 to 20% in radioactivity, but this was observed only in selected patients. In 18 of 19 glioblastomas the findings were grossly abnormal, with 30 to 40% increases. In 14 astrocytomas normal findings were reported in 5 cases. Oligodendromas and neurinomas were as difficult to detect as astrocytomas. The lateral differences were increased ~15% above normal. In 6 out of 7 meningiomas studied the radioactivity increase was from 30 to 50% greater on the affected side, and was restricted to the tumor area. Over two subdural hematomas the radioactivity was diffusely increased by ~30%. In vascular impairments 60% of the cases gave normal results. In 31 patients who were followed up after tumor removal, the findings were generally abnormal. With diffuse gliomas the radioactivity concentrated was increased after the operation, but with meningiomas it decreased. (BBB)

7244 ON THE METHODOLOGY OF EVALUATION OF RADIATION TREATMENT OF BRONCHIAL CARCINOMA. G. Oberhoffer and P. Thurn (Universität, Bonn). Radiologe, 3: 175-82(May 1963). (In German)

The goal of clinical treatment evaluation is to compare the progress of diseases using different methods of treatment, and to draw a conclusion as to their relative effectiveness. Improvement can be taken as indication of a treatment effect only if all other factors that could affect the results are excluded as possible error sources. In radiation treatment of bronchial carcinoma it is probably best to compare survival time, using as a starting point the time when a treatment is started. This is more dependable than attempting to draw a conclusion from the estimated onset of the disease, which often cannot be accurately determined. Three sets of factors can affect the homogeneity of irradiated comparison groups. These are known, excludable factors, such as antibiotics, corticoids, cytostatic agents, or concurrent diseases. Factors known, but which cannot be excluded are the variable topography of the tumor, which may affect its detectability and cure, the developmental stage when treatment or observation of the tumor is started, the associated question of classification and radiosensitivity of the tumor, and the variable histological character of the tumor. Age and sex are also variants in a treatment comparison group. Unknown factors may also influence treatment comparisons. To exclude these, patients should be assigned to groups as

strictly as their tumor characteristics will permit. Beyond this, the patients can be assigned in a random configuration, or the type and amount of radiation dose may also be assigned in a randomized pattern. The main disadvantage of extremely detailed patient subclassification is a decrease in the statistical validity of findings. Assuming that satisfactory patient groups are available for comparison, there is still the question of which parameters or criteria can be used to characterize the groups. An average value and its deviation range must be established, and the results presented graphically. Electronic computers will be very valuable to make final statistical comparisons, and demonstration of small differences may require extensive analytical facilities. (BBB)

7245 ISODOSE CHARTS FOR OBLIQUELY INCIDENT ^{60}Co TELETHERAPY BEAMS. E. M. Campbell and Than Tun (Manitoba Cancer Treatment and Research Foundation, Winnipeg, Can.). Radiology, 83: 1073-9(Dec. 1964).

A rapid and accurate method of obtaining isodose charts for obliquely incident ^{60}Co teletherapy beams is described. The method entails the modification of normal incidence isodose charts which are usually readily available in radiotherapy departments. A diagram is presented, indicating corrections to allow for the deficiency or surplus of tissue encountered with beams of oblique incidence. Application of these corrections to the normal incidence isodose curves results in isodose charts for the obliquely incident beams with discrepancies of less than 2% when compared to measured isodose charts. (auth)

7246 A RADIATION PROTECTION SHIELD FOR USE IN THE OPERATING ROOM. Noel F. Strasser, George Krawzoff, Harry A. Lerner, and John H. Gilmore (West Suburban Hospital, Oak Park, Ill.). Radiology, 83: 1098-9(Dec. 1964).

Description is given of a radiation protection shield for use in the operating room. The device is an L-shaped protective lead block, weighing approximately 120 lb and 2 in. thick, placed on a stainless steel, heavy-duty utility cart and rolled into the operating room. The shield reduced radiation exposure to the operator from 26.6 mR to approximately 1.65 mR. The shield also permits unhurried applicator preparation for optimum patient treatment. (P.C.H.)

7247 SOME ACHIEVEMENTS IN RADIOISOTOPE DIAGNOSIS IN THE OUTPATIENT DEPARTMENT OF THE M.F.A. I. Martinovici, V. Wasserstrom, H. Herscovici, I. Ioanescu, and Gh. Tucu. Rev. Sanit. Mil., 40: 667-73 (July-Aug. 1964).

Descriptions are given of cardioscintigraphy, hepatic scintigraphy (rose bengal ^{131}I, colloidal ^{198}Au) thyroid scintigraphy, radionephrocystography (Hippuran ^{131}I), latter done in 96 cases, renal scintigraphy, ^{32}P in diagnosis of mammary, orbital, ophthalmic, and skin tumors (56 patients) with detailed discussions on the techniques. (OTS)

7248 THE TREATMENT OF THYROID GLAND DISEASES WITH RADIOACTIVE IODINE. H. E. Brunner and A. Labhart (Universität, Zurich). Schweiz. Med. Wochschr., 91: 1269-72(Oct. 28, 1961). (In German)

The most uncertain factor in treatment of the thyroid gland by administration of radioiodine is the estimation of the gland's volume. This can be done only by inspection and palpation. Sometimes radioisotope scanning can give a more exact value. One simplifying assumption is to consider the lobes of the gland as ellipsoids. Each can be delimited by palpation and by measurement of the three axes. In this way the volume can be calculated relatively accurately with an error of ~10%. The treatment of hyperthyroidism with radioiodine can give euthyroid results in as high as 90% of patients treated. In 75 patients with nontoxic goiter, using an average dose to the thyroid of 12000 Rad, the size of the gland was reduced by ~50% within 3 to 6 months. No instances of hypothyroidism appeared after the treatments. However, too few case histories are available on which to base a final decision as to the advisability of radioiodine treatment for large, inoperable goiters. Treatment of malignant thyroid carcinomas generally consists of a combination of surgical, pharmacological, and radiological measures. Surgical intervention is basically the best treatment procedure, with the other treatments as second choices. One absolute requirement for effective treatment is that the tumor must have a capacity to incorporate the radioisotope. This tends to restrict its use to the relatively benign, highly differentiated tumors, such as papillomas, metastasizing adenomas, and the rapidly growing Langhans tumors. The undifferentiated carcinomas and sarcomas do not incorporate radioiodine. Another requirement is the complete surgical removal of functional thyroid tissue, so that whatever extrathyroidal tissue that can be stimulated by thyrotropin to take radioiodine up will be made apparent. The absorbed radiation treatment dose should be no less than 30000 Rad. Only ~25% of malignant thyroid tumors are suitable for radioiodine treatments. Side-effects may occur at this radiation level. (BBB)

7249 HEMANGIOMA TREATMENT WITH STRONTIUM-90. Wolfgang Schmidt (Strahlentherapeutischen Klinik der Medizinischen Akademie, Magdeburg, Ger.). Strahlentherapie, 125: 406-12(Nov. 1964). (In German)

For the therapy of nevi flammei and hemangiomas ^{90}Sr sources with activities of 10, 40, and 70 mCi in air tight metallic containers are used. Treatment technique, dosage, and therapeutic results are reported along with dosimetric results. 85 references are included. (P.C.H.)

7250 THE DIAGNOSIS OF CANCER WITH RADIOISOTOPIC TECHNIQUES. Norman B. Ackerman (Univ. of Minnesota, Minneapolis). Surg. Gynecol. Obstet., 118: 1333-45(June 1964).

A literature review is presented of 124 publications that discuss recently developed techniques, employing radioisotopes, for the detection of cancer. In detection of thyroid neoplasia, ^{125}I has been introduced and used for thyroid scanning; because of the favorable γ radiation, a smaller dose can be used and resolution and contrast are increased in scanning. A different approach to the diagnosis of thyroid cancer by measuring the uptake of ^{32}P with a small Geiger-Mueller counter has also been described recently. Malignant tissues had at least a 30% greater uptake of ^{32}P than normal tissue. A method using ^{131}I and ^{32}P has been described for the diagnosis of mediastinal masses. It is said to be able to distinguish between substernal thyroid, high ^{131}I; rapidly growing tumors such as lymphomas, high ^{32}P; and inactive masses, including cysts and fibromas, low ^{32}P and low ^{131}I. Breast cancer has been detected in high frequency (80%) by a new method employing ^{42}K. A new method for differentiating between aneurysm and tumor in patients with mediastinal masses is conducted by intravenous injection of 500 μC of radioiodinated serum albumin, scintillation scanning being performed over the chest. If an aneurysm is present, the level of radioactivity in this area is high. If a tumor was present, radioactivity over the mass is at background level. There have been more radioisotopic methods devised for the detection of brain tumors than for any other tumor. They are based on the fact that the radioactive substances used penetrate the blood-brain barrier of the tumor more easily than that of the normal brain tissue. Nonneoplastic space-occupying lesions occasionally give false positive results. Brain scanning is now used in many hospitals throughout the country. Radioiodinated serum albumin has probably been the agent of choice for many years, although there has been much interest recently in ^{203}Hg-labeled Neohydrin. The use of several new promising agents is still under evaluation. The clinical applicability of the bone tumor detection techniques is still not certain, nor has it been determined which is the most useful isotopic agent. Many investigative studies are in progress. The major problems include the high background radiation of the body, the digestive tract particularly, and difficulties in distinguishing benign from malignant diseases. (BBB)

7251 THE ECONOMIC ASPECTS OF COBALTHERAPY. E. Weiss. Tech. Hosp. (Paris), 19: 61-3(Aug.-Sept. 1963). (In French)

The following aspects of ^{60}Co therapy are discussed: ad-

vantages over conventional radiotherapy, construction of irradiation apparatus and treatment rooms, installation and maintenance expenses, and calculations of the source strength required for various treatment conditions. During the past five years, ^{60}Co γ rays have almost completely replaced 200-kv x rays in cancer treatment centers. The number of cobalt therapy devices in the world has reached 1000; in the U.S.A. there are 300; in France, 70. It is estimated that these numbers will double within the next five years. With cobalt therapy the patient is more comfortable during treatment, and the skin reactions are milder than those observed with use of 200- to 220-kv x rays. X ray gives relatively high surface doses and low deep doses, and some unnecessary irradiation of healthy tissue surrounding the area in which the tumors are located. With the supervoltage technique, these problems are less likely to occur: the skin reactions are slight, since the maximum ionization takes place beneath the skin, and the deep doses are stronger. At the same time, the unwanted dose received by the healthy tissue is weakened because of less diffuse irradiation. There is more equalization between the energy absorbed by the bones and the soft tissues. Tumors screened by bone can easily be more irradiated, but the risk of death from irradiation may be greater. Supervoltage devices can be used not only in the treatment of very deep tumors, but also for those of the head or neck. Supervoltage treatment is indicated in the following instances: where tumors are too deep to be reached by classical radiotherapy methods; in areas where bone or cartilage is present; in cancer recurrence after an earlier course of therapy. Some financial aspects of installation of ^{60}Co irradiation sources in treatment centers are discussed. Financial conditions permitting, treatment by conventional radiotherapy should eventually be replaced in hospitals and clinics by supervoltage treatment. Cobalt-60 therapy is not the only treatment classified as supervoltage. Also included would be treatment with ^{137}Ce, linear accelerators, and betatrons. The value of medical care, particularly radiotherapy, cannot be measured monetarily; yet the question of the price of installation of machines cannot be ignored, since it must be of prime consideration in the acquisition of new therapeutic equipment. To the actual purchase price must be added the expenses of installation, maintenance, periodic replacement of the source, and salaries of personnel, in addition to the construction of treatment rooms, waiting rooms, and examination rooms. Considered here are two categories of machines, and in each category, two types: devices containing up to 2000°C and those with up to 4000°C; rotating machines and those with a fixed field. The rotating equipment is preferable except when several or many machines are used in the same hospital or clinic. In this case, it is more logical to have both types, rotating and fixed. Despite the fact that they are extremely expensive, the rotating machines possess the great advantage of allowing the patient always to be placed in the same position. When the irradiation is not vertical, it is far simpler to move the patient for treatment than to place the patient in tiring positions. In addition, a far greater number of patients can be treated with one such machine. For this reason the manufacturers have concentrated their efforts on the rotating machines, since it is evident that with this type it is possible to administer all forms of irradiation: circular, rotational, segmentary, and a fixed field. Treatment rooms should be constructed entirely of concrete, except in certain instances where a wall or a ceiling could be of concrete containing barite. The price of such a room is flexible since prices vary with local conditions as well as sizes of rooms. On the average, the cost will be between 60,000 and 100,000 F. The activity of the sources used depends essentially on the type of machine as well as on the number of daily treatments required. In a machine with a 50- to 60-cm source-tumor distance, a source of 1500 C is suitable, whereas for a distance of 80 to 100 cm, 2000 C would be necessary. In other words, the time necessary for administration of 250 R to the tumor depends on the activity of the source in rhm (r/hr at 1-m distance) and the source-tumor distance. In the case of a source of 1500 C, the delivery in rhm is ~1800, giving at 55 cm a dose of ~100 R/min. At a tissue depth of 10 cm over a 15 × 15 cm field the dose would be 60 R; to achieve 250 R, irradiation would require 4 min 7 sec. The loss of activity for a ^{60}Co source is ~1.1% per month, requiring replacement of the source every four years. The cost of sources of various strengths is tabulated, as well as subsequent operating expenses. Specifications of the various commercial devices available are also tabulated. (BBB)

7252 THE DOSE DISTRIBUTION FOR TELECOBALT ROTATORY IRRADIATION ABOUT 2 ECCENTRIC AXES. W. Hess. Thesis, Heidelberg, Universität, 1964. 39p. $2.00(Gmelin, AED-DISS. 64-103). (In German)

The development of radiotherapy is reviewed. Using photometric methods, depth dose distributions from rotatory irradiations with movement about various axes were measured. Results indicate that it is possible to vary irradiation method according to the progress of the disease. (Gmelin Inst.)

7253 METHODS AND RESULTS OF THE I^{131} TRIIODINE THYRONINE TEST WITH AN ION EXCHANGER. R. Schmele. Thesis, Göttingen, Ger., Universität, 1963. 33p. $2.00(Gmelin, AED-DISS. 63-688). (In German)

The diagnostic value of the triiodine thyronine test with Amberlite as ion exchanger was investigated. Retention for man is 13.1% and for woman 12.5%, the difference between the sexes being significant. It was concluded that the test can be important for the evaluation of thyroid function. It has the advantage that the patient is not exposed to radiation. (Gmelin Inst.)

7254 STUDIES OF THE I^{131} TRIIODINE THYRONINE IN VITRO TEST USING AN ION EXCHANGER. W. Hohbach. Thesis, Würzburg, Ger., Universität, 1963. 33p. $2.00 (Gmelin, AED-DISS. 63-619). (In German)

The in vitro thyroid test using ^{131}I labeled triiodine thyronine and an ion exchanger was studied clinically. Results from the test are sufficiently reproducible. Values are influenced by the quantity of the anticoagulant. (Gmelin Inst.)

7255 THE RADIOIODINE TREATMENT OF HYPERTHYREOSIS. R. Pieper. Thesis, Bonn, Universität, 1963. 108p. $2.00(Gmelin, AED-DISS. 63-617). (In German)

Progress in hyperthyreosis therapy is revied. Case histories of 100 patients treated with iodine were analyzed. The patients were under observation from 4 months to 8 years after treatment. Effective thyroid doses were between 2000 and 24000 rep/g; 88% of the treated persons were cured and no serious after-effects observed. A comparison of 3 customary therapy methods (ectomy, antithyroidal substances, and radioiodine) was made. (Gmelin Inst.)

7256 CALCIUM TURNOVER STUDIES WITH INTRAVENOUSLY INJECTED Ca^{47}. E. H. Belcher, R. Fraser, D. H. Gutteridge, G. F. Joplin, and C. J. Robinson. p.102-6 of STI/DOC/10/32.

A method for diagnosing osteoporosis using ^{47}Ca to determine Ca turnover in normal and osteoporotic patients is presented. (H.M.G.)

7257 CLINICAL Ca^{47} DATA: KINETIC STUDIES. J. Malinowska, J. Szymendera, J. Tołwinski, J. Nowosielski, and W. Jasiński. p. 107-10 of STI/DOC/10/32.

Calcium-47 turnover was investigated as a clinical method for diagnosing bone tumors. Differences in miscible Ca pool, mean accretion rates, and body retention of the isotope were evident when normal and diseased patients were compared. However, the differences were not considered significant in view of the total picture. It was suggested that the accretion rate test may be of value in predicting the course of events in malignant disease. (H.M.G.)

7258 RESULTS OF KINETIC ANALYSIS AND OF EXTERNAL COUNTS. K. R. Corey. p.110-12 of STI/DOC/10/32.

Calcium accretion rates were calculated by computer and compared with external counting results. It was found that external counting is much more useful for detection and evaluation of localized bone disease than is accretion rate. (H.M.G.)

7259 ORAL Ca^{47}, A SHORT-TERM TEST OF INTESTINAL CALCIUM ABSORPTION AND BALANCE. V. Parsons, W. J. H. Butterfield, and N. Veall. p.113-18 of STI/DOC/10/32.

Calcium-47 was given orally to 12 controls and 30 patients suffering from a variety of disorders of Ca metabolism. The mean normal net absorption was 26 ± 5%. A wider range with a higher mean (36 ± 14%) was found in osteoporotics. Significantly higher values were found in patients with malignant disease and Paget's disease, in patients with hyperparathyroidism, and those receiving vitamin D. (H.M.G.)

7260 EXTERNAL MEASUREMENTS OF Ca^{47} IN MALIGNANT DISEASE. J. Malinowska, J. Szymendera, J. Tołwiński, J. Nowosielski, and W. Jasiński. p.152-6 of STI/DOC/10/32.

Pathological effects of activities of human bones were studied in 86 patients after intravenous injections of ^{47}Ca. Data obtained by means of external counting over normal and pathological bones did not provide useful information for diagnostic purposes in clinical cancer work. The pronounced scatter of the external time-activity curves over both normal and pathological parts of the skeleton in the pathological group as compared with the control group suggested that Ca metabolism in the group of bone-tumor patients was more labile. (H.M.G.)

7261 HUMAN RICKETS STUDIES WITH EXTERNAL COUNTING OF Ca^{47}. R. Hoffenberg, F. Harris, and E. Black. p.156-60 of STI/DOC/10/32.

After intravenous ^{47}Ca injection, external counting was performed on 8 control infants and six with rickets. In each case, counts were taken over the upper end, the midshaft, and the lower end of the right tibia. The counting rate observed was expressed with reference to the counting rate of a ^{47}Ca standard. In normal infants the upper tibia rapidly accumulated ^{47}Ca, while a lesser, but distinct, increase of activity occurred over the lower tibia. The reverse pattern was obtained in infants with rickets. (H.M.G.)

CHEMISTRY

General

7262 (CEND-508) INVESTIGATION OF CATALYTIC RECOMBINATION OF RADIOLYTIC OXYGEN AND HYDROGEN. Quarterly Report, July–September 1964. Gilbert M. Brown and C. Thomas Sawyer (Combustion Engineering, Inc. Nuclear Div., Dunedin, Fla.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-3151. 37p. (EURAEC-1233). Dep.(mn); $2.00(cy), 1(mn) OTS.

Long-term or endurance testing of catalysts was initiated, and corrosion data were obtained for both high and low oxygen content steam. The test loop which had been used for earlier, Phase I work was altered for use in the presently underway Phase II program. Generally, the loop was altered such that H_2, O_2, and NaCl solution could be added to 900-psig, wet power plant steam which is then used in the tests. This wet (1–3% moisture by weight) steam is then passed over stress corrosion specimens, dried and superheated a few degrees, passed over general surface corrosion coupons, passed over the catalyst bed, passed over a second set of surface corrosion specimens, cooled to wetness again and then passed over a second set of stress corrosion specimens. The steam is then condensed and monitored for chlorides and free oxygen. The three catalysts were operated for seven weeks before evidence of significant apparently permanent loss of activity occurred. This operation was possible irrespective of the injection of many grams of NaCl but required one shutdown necessary for water and steam cleaning of the catalysts for removal of NaCl deposits. The beds collected more than 50% of the chlorides and other solids under dry steam conditions and after approximately one week of operation with steam which contained 5 to 10 ppm total solids, it was necessary to remove and clean the catalysts, as NaCl, O_2, and H_2 "broke through" the beds. This early breakthrough would not occur if high purity reactor steam were used. Both stress corrosion and general corrosion data taken to date show a marked difference in rates when data for 30-ppm O_2 and 0.2–0.5-ppm O_2 concentration conditions are compared. For situations with and without H_2, more rapid, more numerous, and more severe cracking of Type 304 stainless steel U-bend specimens occurred where the high O_2 content was present. While only a small amount of general corrosion data have been obtained to date, it appears that higher oxygen contents increase the corrosion rates of the low alloy materials but that the corrosion rate of the Type 304 stainless, which is very low at the test temperatures (approximately 540°F), is not affected noticeably. (auth)

7263 (ORNL-3651) TRANSURANIUM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 29, 1964. W. D. Burch, comp. (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 75p. Dep.; $3.00(cy), 2(mn) OTS.

Progress is reported on the development of separation processes for the transuranium elements, process equipment development, HFIR target fabrication development, construction of the TRU processing plant, corrosion studies, and analytical research and development. (J.R.D.)

7264 INTERACTION OF PHOSPHORUS-32- AND CARBON-14-LABELLED TRITOLYLPHOSPHATE WITH GLASS SURFACES. Malcolm E. Schrader and Irving Lerner (Naval Applied Science Lab., Naval Base, Brooklyn). Nature, 204: 759-61(Nov. 21, 1964).

The chemical reactivity of tritolylphosphate (TTP) on the surfaces of pyrex and fused silica glasses was investigated. Results indicated that reaction of the TTP on pyrex glass occurs chiefly with the silica network and that the activity is due to reaction with nonsiliceous components. The reactions of TTP on pyrex or fused silica are characterized by the formation of a chemisorbed inorganic P compound joined to the surface by an Si–O–P linkage and by hydrolysis of the TTP by water adsorbed at the surface to produce free phosphoric acid and cresol. (J.R.D.)

Analytical Procedures

7265 (AD-603756) DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF MINUTE QUANTITIES OF SELECTED ELEMENTS IN BERYLLIUM. Interim Report No. 2, March 20–May 20, 1964. W. M. Henry (Battelle Memorial Inst., Columbus, Ohio). June 24, 1964. Contract NOw-64-0081-c. 22p. $1.00(OTS).

Investigations were made to evaluate, especially in respect to trace-gas impurities, different methods of cleaning sample electrodes, of loading into the mass spectrograph, and of baking prior to mass-spectrographic analysis. Conclusions on the effectiveness of the various procedures are tentative; a more accurate readout of the spectra will be made by using a recording microphotometer. (auth)

7266 (AERE-M-1219) THE DETERMINATION OF TRITIUM IN EFFLUENT. B. A. Loveridge (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Apr. 1963. 9p. Dep.(mn).

Sodium hydroxide, sodium sulfite, and sodium iodide are added to 25 ml of effluent and the solution is distilled. A portion of the distillate is mixed with a liquid scintillator and the tritium content determined by beta counting. Decontamination from radio-ruthenium and radio-iodine is excellent. (auth)

7267 (APED-4527) DETERMINATION OF URANIUM AND PLUTONIUM CONCENTRATIONS AND ISOTOPIC ABUNDANCES. B. F. Rider, C. P. Ruiz, J. H. Davies, W. E. Duffy, J. P. Peterson, Jr., and J. F. Hanus (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). May 1, 1964. 25p.

A method is given for determining U and Pu concentrations and isotopic abundances in dissolver solutions of reactor fuels either before or after irradiation. In this method, an aliquot of the solution is spiked with ^{233}U and ^{242}Pu, and the U and Pu are separated by ion exchange and analyzed mass spectrometrically. The precision obtainable ranges from 0.05 to 1 relative % standard deviation, depending on the isotopic abundance. (D.L.C.)

7268 (CEA-R-2436) ETUDE DE L'UTILISATION DE LA DECHARGE ELECTRIQUE EN CATHODE CREUSE COMME SOURCE D'EXCITATION OPTIQUE POUR LE DOSAGE SPECTROGRAPHIQUE DU FLUOR DANS LE THORIUM, L'URANIUM ET LE PLUTONIUM. (Study of the Use of an Electric Discharge for Hollow Cathodes Used as Optical Excitation Sources in the Spectrographic Determination of Fluorine in Thorium, Uranium and Plutonium). Michel Buffereau, Gerard Crehange, and Josette Poublan (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. 89p. Dep.(mn).

Previous work and phenomena concerned with a hollow cathode excitation are reviewed. Experiments are aimed specially on the determination of the best conditions for the analysis of fluorine in oxides, metals, and solutions. In that purpose, several factors have been pointed out. Research on other elements than fluorine is considered. Carrying fluorine into discharge and excitation have been more specially studied. A quantitative analysis method is given. The analysis limit is about 45 ppm but the detection limit is about 5 ppm. Various ways for optical excitation of fluorine are reviewed as a hollow cathode discharge offers other analytical possibilities. (auth)

7269 (CEA-R-2538) UTILISATION D'UN SPECTROMETRE γ MULTICANAUX EN VUE DE MESURES QUANTITATIVES APPLIQUEES A LA RADIOPROTECTION. (Use of a Multichannel γ Spectrometer for Quantitative Measurements in Radioprotection). Jean Cluchet (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Sept. 1964. 30p. Dep.(mn).

The advantages, in radioprotection, of using γ spectrometry for analysis of radioelements are pointed out. A simple and rapid method for dosing several radioelements in one sample is described. With a view to measuring the sources used for the calibration of detectors, it is shown that it is possible to determine the photon flux at one given point and to deduce from it the intensity of the irradiation due to each γ line. The sensitivity and the accuracy of the measurements are discussed. (auth)

7270 (EUR-2159.e) WATER DETERMINATION IN TERPHENYLS USING THE KARL FISCHER COULOMETRIC TITRATION. R. Veneroni and R. Friesen (European Atomic Energy Community, Joint Nuclear Research Center, Ispra, Italy). 1964. 60p. Dep.(mn).

The development of a discontinuous method for the determination of water in terphenyl during static autoclave corrosion tests is reported. The method is especially useful for relatively small samples (0.5–2 g) and low water concentrations (5–100 ppm). Samples are collected in glass vials, the vials being sealed, if the samples are to be kept for a long time. A correction can generally be made if interfering compounds are present in the terphenyl. In the usual range of 10–100 ppm, the standard deviation is about 3 ppm. (auth)

7271 (IA-790) DETERMINATION OF BARIUM IN THE PRESENCE OF STRONTIUM AND CALCIUM BY COMPLEXOMETRIC TITRATION WITH EDTA. W. Tuler (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Aug. 1964. 10p. Dep.(mn).

A method is described for the complexometric determination of Ba in the presence of Sr and Ca without phase separation. The method is based on the determination of the total alkaline earths (Ba + Sr + Ca) using EDTA and on the titration of Ca + Sr in presence of freshly precipitated $BaCrO_4$. Nitrobenzene is used as a surface coating agent which prevents both adsorption of the $BaCrO_4$ precipitate and redissolution of the $BaCrO_4$ precipitate. Erio Chrome Black T is used as indicator. The method is rapid and accurate. As little as 1 mg Ba can be determined in the presence of almost equivalent amounts of Sr and Ca. (auth)

7272 (IAEA-R87-1) DEVELOPMENT OF A METHOD OF NONDESTRUCTIVE ANALYSIS OF IRRADIATED FUEL ELEMENTS FOR URANIUM-235 AND PLUTONIUM CONTENT BY MONITORING AND SPECTROMETRY. Progress Report, January 1–November 30, 1962. (Società Nazionale Metanodotti, Milan). Contract 87/R1/RB. 9p. Dep.(mn).

Progress is reported on the assessment of the method of determining the fuel element burn-up and plutonium content by means of irradiation of uranium foils and subsequent analysis of the alpha spectrum. The work has been mainly devoted to the attempt of improving the resolving power of the instrumentation for alpha particle detection using solid-state-type detectors. A set of 15 samples of uranium 20% enriched in uranium-235 has been prepared for irradiation in the SORIN reactor. The irradiation is due to start before the end of December 1962. (auth)

7273 (IAEA-R87-2) DEVELOPMENT OF A METHOD OF NONDESTRUCTIVE ANALYSIS OF IRRADIATED FUEL ELEMENTS FOR URANIUM-235 AND PLUTONIUM CONTENT BY MONITORING AND SPECTROMETRY. Final Report. (Società Nazionale Metanodotti, Milan). Nov. 30, 1963. Contract 87. 89p. Dep.(mn).

Development work was conducted on the proposed method in which thin uranium films in boxes are irradiated along with the fuel elements and then analyzed for alpha activity. Semiconductor detectors were used to obtain the high resolution required for the determination of ^{235}U. The high beta background of the irradiated films was eliminated by reprocessing methods. The application of the method to fuel elements is considered. (D.L.C.)

7274 (IDO-14636) ANNUAL REPORT OF DIVISION ANALYTICAL BRANCH FOR 1963. Ralph C. Shank, et al. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). June 1964. Contract AT(10-1)-205. 217p. Dep.; $6.00(cy), 3(mn) OTS.

The cause for high bias with respect to theory for the controlled potential-coulometric reduction of U (VI) to (IV) in a sulfate electrolyte was traced to dissolved O_2 in the electrolyte. Reversed phase chromatography is being investigated as a rapid preseparations method for U prior to coulometric analysis. Experiments are reported on the measurement of the rate constant of the U (V) disproportionation reaction. In support of the Waste Calcining Facility, remote analytical apparatus was designed and placed in operation. An air elution method is described for the determination of particle size of WCF product. Also described is a method for the determination of low levels of Hg in the product. An evaluation of factors which affect liquid counting was initiated. A long range program was undertaken to adapt heterogeneous isotopic reactions to routine radiochemical methods. A 1-hr separation method was evolved for the separation of ^{85}Kr and ^{133}Xe from irradiated fuel off-gas. A rapid method is described for the determination of ^{54}Mn in activated stainless steel samples. A method was developed for the determination of ^{132}Te in short-cooled fission product samples. A method was devised for the determination of trace levels of ^{232}U and ^{228}Th in ICPP enriched U product. ^{208}Tl was separated from a ^{228}Th source by collection of ^{220}Rn on a Cu cathode in a gas cell and final separation of the grown-in ^{208}Tl by oxidation and extraction into ether. Existing methods for total U in which extraction of U (VI) is used for preseparation were modified to include a $KMnO_4$ oxidation. An anion exchange procedure was developed for the separation and concentration of trace levels of U in reactor water. Conditions were established for the precise determination of Mg levels of B in metal samples based on cation exchange separation and mannitol-acid-base titration. A selective extraction in situ spectrophotometric method was developed for four rare earth elements. Enhanced absorption of one peak of the nitrate complexes of Nd, Er, Ho, and Sm is obtained in the extraction system. The aqueous phase is acid deficient aluminum nitrate; the extractant is nitroethane containing tetrabutylammonium nitrate. Highly selective titrimetric and colorimetric methods were developed for the determination of Fe. Initial separation is by reversed phase chromatography into 2-octanone on a fluorinated hydrocarbon support. The previously developed method for dibutylphosphate was modified to include aqueous samples containing large concentrations of metal ions. Methods were developed for the determination of picric acid and mononitrophenols in ICPP process solutions. A long range program was initiated to evaluate EDTA titrimetric methods for metal ions. Experimental data are presented showing that commerical spectrographically pure standard compounds, particularly metal oxides, are not stoichiometric and contain less metal than indicated by the formula. In support of the MTR Reactivity Measurements Program, methods were developed for the analysis of Bi–Th alloys; the determination of Hf from HfO–aluminum alloys; the determination of In in In_2O_3–PbO powder mixtures; the determination of Nd in Nd_2O_3–aluminum alloys; the determination of Lu in Lu_2O_3–Cu alloys; the recovery of U from UO_2–ThO_2 and UO_2–ThO_2–PbO_2 mixtures; the determination of the metal-to-O_2 ratios in UO_2, ThO_2, and PbO_2; and the separation and determination of Li in Pu–Al and U–Al alloys. A corrosion-resistant gage was developed for pressure measurement of gases such as aqua regia dissolver off-gas. In support of the STEP reactor accident study program, an analytical program was established for the SNAPTRAN 2/10A-3 abort test. A method was developed for the carrier free determination of radioiodine in water collection samples. The absorption of young fission products was measured for various surfaces proposed for use in the STEP experiments. Development of analytical methods and remote analysis apparatus was completed for samples from fissio-chemical hydrazine production, MTR in-pile loop. High precision methods were developed for the determination of hydrazine and ammonia in the loop

liquid samples. Digestion pretreatment procedures and spectrophotometric methods for Fe, Cr, Ni, Co, Mn, and Zr were evaluated for descaling solutions of irradiated Zr-clad fuel elements. The major effort in a program for fuel burnup determination is measurement of the fission yields of stable fission product nuclides for fissionable isotopes ^{232}Th through ^{241}Pu at thermal, resonance, and fast neutron fluxes and the measurement of the capture cross sections of the stable fission product nuclides. A new approach of burnup analysis is being investigated which is based on the ratio of two fission product nuclides of the same element. Carrier free separation methods were developed for several stable fission product elements including the rare earths, Pd, and the inert gases. Dissolution conditions, designed for quantitative recovery of U and fission products, were developed for U metal, U–Al alloys, and U–Zr alloys. The precision for the routine analytical methods is summarized. Stability of U solutions was maintained for greater than 1-year periods in special dispensing bottles. Spectrographic procedures were developed for analyzing the B_4C content of stainless steels, for elements in Westinghouse Expended Core Facility descaling solutions, for Be in presence of large amounts of Zr in addition to procedures for many one-of-a-kind samples. (auth)

7275 (NAA-SR-Memo-10133) THE DETERMINATION OF TRIPHENYLENE IN IRRADIATED ORGANIC REACTOR COOLANT AND HIGH BOILER SAMPLES BY GAS CHROMATOGRAPHY. R. C. Shepard (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 18, 1964. Contract AT-11-1-GEN-8. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A gas chromatographic method for the determination of triphenylene in irradiated terphenyl mixtures is described. Samples in tetrahydrofuran solution are chromatographed on 3 meter columns packed with 20% Dow-11 Silicone on 42/60 mesh firebrick held at 305°C. A weighed amount of 1,3,5-triphenylbenzene is added to serve as an internal standard. The triphenylene concentration is calculated from peak area measurements. The standard deviation for precision which resulted for 28 runs carried out on known mixtures of triphenylene and internal standard was ±2.0%. Accuracy of the determination is subject to the limitation that the "triphenylene peak" area, as measured, may contain contributions from other components (such as polyhydrotriphenylenes) which are not separated from triphenylene under the conditions employed. The triphenylene contents of 11 Core II OMRE coolant samples and 4 HB samples were determined. Their relation to the average molecular weights of the HB fractions and to reactor operation are discussed. (auth)

7276 (ORNL-TM-1009) SEPARATION AND IDENTIFICATION OF VOLATILE IODINE COMPOUNDS BY FRACTIONAL SUBLIMATION AND MASS SPECTROMETRIC ANALYSIS. M. E. Davis and W. E. Browning, Jr. (Oak Ridge National Lab., Tenn.). Nov. 30, 1964. Contract W-7405-eng-26. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A suspected non-elemental form of iodine was separated from a sample of elemental iodine by fractional sublimation under vacuum and was identified as methyl iodide by mass spectrometric analysis. An upper limit of 0.08% was set on the amount of methyl iodide in the elemental iodine source. The possible presence of hydrogen iodide and trace amounts of ethyl iodide was indicated. This method might be adapted profitably to the study of the chemical forms of fission-product iodine that might be accidentally released from nuclear facilities. (auth)

7277 (RFP-438) TECHNIQUES FOR C-H ANALYSIS ON RADIOACTIVELY CONTAMINATED MATERIALS. Otis H. Willoughby, Jr. (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). [1964]. Contract AT(29-1)-1106. 2p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A technique was developed for the combustion of radioactively contaminated organic materials in a C-H analyzer without the possibility of accidental release of radioactivity. In this technique, a combustion boat is formed by rolling a small square of Al foil around a tapered mandrel, the sample is weighed into the open end of the cone, and this end is sealed. The loaded boat is then transferred from the glove box to a combustion tube, whose open end is covered. (D.L.C.)

7278 (RT/CHI(64)-18) DETERMINAZIONE DEL CONTENUTO DI U-235 IN CAMPIONE DI URANIO MEDIANTE SPETTROMETRIA GAMMA. (Determination of U-235 Content in Samples of Uranium by Means of Gamma Spectrometry). V. Pompei (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Aug. 1964. 21p. Dep.(mn).

A simple method is described which allows the determination of ^{235}U isotopic abundance. The method is based on the use of gamma spectrometry to measure the 184-kev gamma photons from the decay of ^{235}U. The area under the photopeak obtained provides the quantitative estimation of amount of ^{235}U. The method is rapid and nondestructive, precision is within 0.5% over the concentration range 0.5 to 100%, and the limit of sensitivity is about 0.5% ^{235}U. (auth)

7279 (RT/CHI(64)-19) ANALISI POTENZIOMETRICA DEL CONTENUTO IN CLORO NEI TERFENILI COMMERCIALI. (Potentiometric Analysis of the Content of Chlorine in Commercial Terphenyls). C. Bordonali, T. Bazzan, M. A. Biancifiori, and F. Salvemini (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). July 1964. 12p. Dep.(mn).

The chlorine impurity in commercially available terphenyls is determined by potentiographic titration with $AgNO_3$. It is first decomposed to NaCl by reaction with sodium-biphenyl in xylene. The solution is then homogenized and conductivity is assured by adding methyl alcohol and acetone. 10 γ of Cl is the detection limit with a standard deviation of 20%. The quantity of sample needed is 5 g. (auth)

7280 (RT/CHI(64)-22) DETERMINAZIONE DELLE CENERI NELLE MISCELE DI TERFENILI. (Determination of Ash in Terphenyl Mixtures). C. Bordonali, B. Rossi, and A. Brignocchi (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Sept. 1964. 11p. Dep.(mn).

A method is given for determining the ash content in polyphenyl mixtures up to a level of 0.5 ppm. The sample is calcined at 900°C in a muffle furnace after burning at ~280°C in hood. The sample is then weighed on a semimicro analytical balance. Standard deviations at the 5000γ and 200γ levels are respectively S = 80γ and S = 4.5γ. The possibility of a determination on the soluble Fe has been studied. (auth)

7281 (CEA-tr-X-574) DETERMINATION DE LA RADIOACTIVITE β TOTALE DANS L'URINE. (Determination of the Total β Radioactivity in Urine). J. Bilkiewicz ([Poland. Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. Centralne Laboratorium Ochrony Radiologicznej, Warsaw]). Translated into French from report CLOR-14. 1962. 18p. Dep.(mn); $1.60(fs), $0.80 (mf) JCL.

A method for the determination of β active radionuclides in urine is presented. It is convenient for preliminary monitoring of personnel exposed to the risks of internal contamination. The principle of the method is the precipitation of the active substances with a deposit of phosphates of alkaline-earth elements in an ammonium medium. The filtered deposit is burned in a furnace to eliminate the organic parts. The β radioactivity of the tared ash is measured. The sensitivity and the common errors are described. (J.S.R.)

7282 DETERMINATION OF CERIUM IN FERROUS ALLOYS. S. S. Ahluwalia and J. Korkisch (Universität, Vienna). Anal. Chim. Acta, 31: 552-6(Dec. 1964).

A method for the determination of cerium in ferrous alloys is described. Cerium (with lead and bismuth) is separated from other elements by anion exchange in a medium consisting of 95% methanol and 5% 5N nitric acid; cerium alone is then eluted with 90% methanol-10% 6N hydrochloric acid and determined in the eluate by titration with

EDTA to xylenol orange indicator. Application of the method to several steel samples was successful. (auth)

7283 THE DETERMINATION OF ZINC IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. R. H. Filby (Universitet, Oslo). Anal. Chim. Acta, 31: 557-62(Dec. 1964).

A neutron activation method for the determination of zinc in rocks and minerals is described. The method is precise, accurate, and has a sensitivity of 0.01 ppm of zinc. An ion-exchange separation of zinc together with precipitation of zinc as oxinate, gave good yields. Interference from conflicting (n,p), (n,α) and ^{235}U(n,f) reactions was negligible. The zinc contents of G-1 and W-1 standards determined by the method were 45.7 and 82.8 ppm of zinc, respectively. (auth)

7284 THE DETERMINATION OF OXYGEN IN PLUTONIUM AND ITS COMPOUNDS BY EMISSION SPECTROSCOPY. M. Chaput and J. N. Savarit (Commissariat à l'Énergie Atomique, Fontenay-aux-Roses, France). Anal. Chim. Acta, 31: 563-75(Dec. 1964). (In French)

The Fassel method was applied to determination of oxygen in various plutonium compounds by emission spectroscopy. Technical difficulties were found in adapting the method for radioactive materials; these were partially overcome by the introduction of a special electrode carrier, but the volume of the carrier was established as too large to enable the full possibilities of the method to be exploited. A lower sensitivity limit of 250 ppm was found for a 200-mg sample; the precision obtainable was of the order of 40%. (auth)

7285 PREPARATION OF FLUX MONITORS USEFUL FOR ACTIVATION ANALYSIS IN A NUCLEAR REACTOR. A. Travesi Jimenez (Junta de Energia Nuclear, [Madrid]). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 363-80(May 1964). (In Spanish)

Marked variations of the neutron flux at very close irradiation positions in the JEN-1 reactor requires the use of flux monitors to allow correction of these variations when the reactor is employed for activation analysis. Among the different materials useful for that purpose, an aluminum alloy with 0.1 and 0.5% cobalt was chosen; the work carried out to prove its usefulness is described. Gamma spectrometry was applied to study the influence of the impurities, the existence of which was tested by spectrographic analysis of the raw materials used and of the alloys; results obtained were compared with those derived from analogous alloys used at other laboratories. The application of activation analysis allowed checking of the homogeneity of the alloys, within narrow limits. (auth)

7286 AN ION-EXCHANGE COLUMN FOR USE WITH ATOMIC-ABSORPTION ANALYSIS. D. J. David (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Analyst, 89: 747-8(Nov. 1964).

In the determination of strontium in biological materials by atomic absorption, phosphate is removed by means of an anion-exchange column to overcome its depressive effects on strontium absorption. Design and operation of a resin column for this purpose are discussed. The column described combines a fast flow rate with high efficiency resulting from the small and controllable volume of liquid in the column itself. Further, after a small initial adjustment, the column can be left, without attention or fear of air entering the resin bed, until after all of an applied volume of liquid is exhausted. (M.C.G.)

7287 SIMULTANEOUS MEASUREMENT OF TRITIUM AND ^{14}C IN AQUEOUS SOLUTION WITH THE LIQUID SCINTILLATION COUNTER. L. Traeger (Universität, Frankfurt am Main). Atompraxis, 10: 472-5(Nov. 1964). (In German)

It was found that, using a liquid scintillation counter, isotopes can be determined simultaneously in specimens without a quenching effect in a range between $10 > {}^{14}C/T > 0.0017$ with a relative standard deviation not exceeding ± 3%, if 10 measurements of 5 minutes each are taken as a basis. A simple equation pair was specified to calculate the absolute single activities. The standard deviations of 15 pairs of values are given for measurement samples with increasing $^{14}C/T$ quotients as well as for measurement of unmixed single isotopes. (auth)

7288 DETERMINATION OF ^{32}P WITH HELP OF ČERENKOV-RADIATION AND BY USE OF AN IMPROVED INTERNAL STANDARD. H. Vemmer and J. O. Guette PUniversität, Gottingen, Ger.). Atompraxis, 10: 475-7 (Nov. 1964). (In German)

A method is described for a simple counting of ^{32}P by Cherenkov radiation in a liquid scintillation spectrometer. Counting efficiency was 31%. Errors caused by unequal composition of samples were excluded by use of an improved internal standard. (auth)

7289 ISOTOPIC DILUTION DETERMINATION OF CALCIUM AND MAGNESIUM ON THE MICROGRAM SCALE. R. Delwiche and M. Vosters. Bull. Soc. Chim. Belges, 73: 255-67(1964). (In French)

The quantitative analysis of Ca and Mg by isotopic dilution is described. The theory of isotopic dilution is recalled and a description of the apparatus used is given. The concentrations of standard solutions of Ca and Mg were tested by this method. The results show that it is possible to measure quantities of these elements at the microgram level with an accuracy of 2 to 5% (2σ%). The main limitations of this method are due to contaminations during handling, and moreover, for Ca, to isotopic fractionation. (auth)

7290 POLAROGRAPHIC DETERMINATION OF URANIUM IN THE WASTE SOLUTION OF NUCLEAR FUEL REPROCESSING. Kenji Motojima, Hiroshi Okashita, and Tamotsu Sakamoto (Japan Atomic Energy Research Inst., Ibaraki). Bunseki Kagaku, 13: 1097-1100(Nov. 1964). (In Japanese)

Determination of micro amounts of uranium in the waste solution of nuclear fuel reprocessing (Purex method) was investigated polarographically. The waste solution contains HNO_3, HNO_2, organic substances, fission products, corrosion products, and radiolyzed substances. The uranyl wave is affected seriously by these coexisting substances. Disproportionation effect of U(V) was eliminated by adding $(NH_4)_2SO_4$ to the sample solution. The organic substances were extracted by stirring the sample solution with benzene in the polarographic cell. HNO_2 was removed by passing through the solution with an alcohol-saturated nitrogen gas. The following procedure was suggested: 1M$(NH_4)_2SO_4$ and benzene is taken in a polarographic cell. Then the sample solution is poured into the cell and deaerated by a purified nitrogen gas for 10 minutes. If HNO_2 is contained in the sample solution, the solution is bubbled with an alcohol-saturated nitrogen gas for 1 minute. The d-c polarogram is recorded from 0 to −0.5 v. Uranium content is determined by using the calibration curve. This method is considered applicable to the determination of uranium in the waste solution ranging from 5×10^{-5} to 5×10^{-3}M uranium. (auth)

7291 SPECIFIC DETECTION OF BARIUM AND STRONTIUM BY DISODIUM TETRAHYDROXYQUINONE PAPER. Yukiko Tanaka and Yoshimasa Tanaka (Kumamoto Univ., Japan). Bunseki Kagaku, 13: 1101-3(Nov. 1964). (In Japanese)

A specific method for determination of barium and strontium was investigated. A drop of test solution was placed on disodium tetrahydroxyquinone paper and the test paper was treated with ammonium oxalate solution or potassium sulfate solution. The red spot of barium salt was unchanged by ammonium oxalate although the fleck of strontium was decolorized. The red spot of strontium was not changed by potassium sulfate, but the fleck of barium disappeared, and both ions were easily distinguished. In the presence of heavy metal ions, sodium diethyldithiocarbamate was used for the elimination of their disturbance. (auth)

7292 HIGH-SENSITIVITY GAS CHROMATOGRAPHY USING β-RAY IONIZATION DETECTOR. Masao Maruyama and Yutaka Morooka (Chuo Univ., Tokyo). Bunseki Kagaku, 13: 1109-16(Nov. 1964). (In Japanese)

A β-ionization detector originally designed as an argon detector proved useful for other purposes if its operating conditions such as applied voltage and carrier gases, were

properly selected. It behaved, for instance, as an electron-capture detector when it was used with nitrogen and with an extremely low applied voltage on the detector. It also acted as a cross-section ionization detector, when helium was used as a carrier gas under an increased applied voltage. The performance of such a detector was not expected to be comparable to specifically designed detectors, but experiments showed that the sensitivity in the determination of nitrobenzene by the proposed method reached ¼ to ⅓ of that attained by an electron-capture detector designed for that purpose. (auth)

7293 EXTRACTION OF METALLIC IONS BY MIXTURES OF ORGANIC REAGENTS. Libor Kuca (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Chem. Listy, 58: 763-77(July 1964). (In Czech)

New ideas concerning the extraction of metal ions with mixtures of organic reagents, which constitutes one of the interesting fields of organic chemistry are summarized. It was found fruitful to approach the extraction system considering all components as a whole and not assuming a priori inertness of some components. The summary is categorized according to mixtures of different types of compounds. Thus, synergistic effects are discussed for mixtures of chelate formers (such as TTA) with various phosphate esters, phosphonates, phosphine oxides, etc. A second category is that of mixtures of acids (such as di-2-ethylhexyl phosphoric acid) with neutral phosphorus compounds (phosphates, etc.). The third category discussed is that of mixtures of amines with other extractants, particularly chelate formers. 90 references are included. (TTT)

7294 SEPARATION OF TITANIUM, ZIRCONIUM, AND THORIUM BY REVERSE-PHASE PAPER CHROMATOGRAPHY. Chih-teh Hu and Shiu-chun Hsieh. Chemistry (Taipei), No. 3, 47-8(1963).

The chromatographic separation of titanium, zirconium, and thorium with nitric acid of various concentrations as mobile phase on paper impregnated with n-tributylphosphate (TBP: C_6H_6 = 30:70) was investigated. Zirconium could be separated from thorium and titanium in 1-6N solution of nitric acid, and the R_f values of zirconium decreased with increasing concentration of nitric acid, while those of titanium and thorium remained almost constant with varying concentrations of nitric acid; the limiting proportions of zirconium to thorium were found to be 1:1000; the R_f values were stable when the paper strip was not saturated with vapor of mobile phase. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 2, 1964)

7295 ATP DETERMINATION WITH THE TRICARB SCINTILLATION COUNTER. E. Tal, S. Dikstein, and F. G. Sulman (Hebrew Univ., Jerusalem). Experientia, 20: 652(1964).

The adaptation of a liquid scintillation counter for determination of ATP (adenosine triphosphate) is described. Amounts as small as 10^{-11} moles could be determined in the presence of luciferin-luciferase. (M.C.G.)

7296 APPLICATION OF THE XYLENOL ORANGE IN CALORIMETRIC ANALYSIS. I. COLORIMETRIC DETERMINATION OF SMALL AMOUNTS OF SCANDIUM. Mei-ling Kung. Hua Hsueh Hsueh Pao, 29: 223-6 (1963).

The stable purple-red complex of xylenol orange and scandium (III) can be utilized for colorimetric determination of scandium. It was found that the solution should be adjusted to pH 2.2-2.45. Optical density should be measured at 560 mμ, where the maximum absorption of the complex occurs. Small amounts of trivalent rare earth metals, iron (III), manganese (II), and aluminum do not interfere, while sulfate, phosphate, fluoride, oxalate, thiourea, ascorbic acid, and nitrilotriacetic acid interfere seriously. Among the reductants studied, thioglycolic acid interfered the least. The interference due to thorium can be eliminated by determining thorium separately and then deducting it from the sum of thorium and scandium (100 μg of thorium corresponds to 41 μg of scandium oxide in the xylenol orange determination). (Sci. Abstr., China, Chem. Chem. Technol., 2: No. 1, 1964)

7297 ON THE DETERMINATION OF DEUTERIUM OXIDE BY MEANS OF THE FALLING-DROP METHOD. Te-Chiu Chin and Tsing-lien Chang. Hua Hsueh Hsueh Pao, 29: 266-76(1963).

n-Butyl benzoate is proposed as a new medium for the falling drop method of determining deuterium oxide in a sample of dilute heavy water. It is suitable for analysis in the concentration range of 0-10.5 mole % D_2O at working temperatures 22-33.5°C. A mixed medium composed of n-butyl and isobutyl benzoate in about 1:1 ratio can be applied to analysis for 0-7 mole % D_2O at working temperatures 21.5-26.5°C. Isobutyl benzoate can be used at 20.5°C for analyzing 0-4 mole % D_2O. Calibration curves for these media are shown. The relative error of determination is about 0.1%. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 1, 1964)

7298 ON THE SEPARATION OF RARE EARTH ELEMENTS BY MEANS OF REVERSE-PHASE PAPER CHROMATOGRAPHY. I. THE HDEHP-Na_2SO_4 SYSTEM. Shu-wei Pang and Shu-chuan Liang. Hua Hsueh Hsueh Pao, 29: 319-23(1963).

A reverse-phase paper chromatography technique was applied to the separation of rare earth elements. As the stationary phase, chromatographic paper strips (Whatman No. 1 and S and S 2045a) were treated with a solution of di(2-ethylhexyl) phosphoric acid (HDEHP) in toluene. Acidified sodium sulfate solutions were used as eluents. It was found that the R_F values of rare earth elements would decrease with decreasing acidity and sodium sulfate concentration of the eluent. For a given acidity of eluent, the more basic the rare earth element, the greater would be its R_F value. It is considered feasible to separate the terbium group from the cerium group with a 0.5M sodium sulfate solution of ca pH 1, and after cutting off the original spot (the yttrium group), it can be eluted with a 0.5M sodium sulfate of higher acidity (say 2.0N). The effects of various parameters on the R_F values of rare earths, such as the quantities of HDEHP retained by paper, temperature of elution, and the presence of cations in eluent (R_F values being alike with sulfates of lithium, sodium, potassium, ammonium and magnesium) were examined. Finally the separation of several mixtures was carried out successfully: La-Ce-Pr-Nd-Sm-Y; Sm-Eu-Gd-UO_2^{2+}; Ce-Eu-Tb-Tm; and La-Pr-Nd-Sm-Eu-Gd. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 1, 1964)

7299 COMPLEXOMETRIC PHOTOMETRIC TITRATION OF MICROGRAM AMOUNTS OF RARE EARTHS. Hou-chi Wang and Cheh-ching Wu. Hua Hsueh Hsueh Pao, 29: 352-6(1963).

A method using arsenazo III as indicator for photometric titration of microgram quantities of rare earths with EDTA is proposed. The optimum pH range for the titration is 4.5-6.4. Under this condition, arsenazo III forms a green complex giving a maximum absorbance at 600 mμ. An exact value for extinction at the equivalence point was calculated with Ringbom's equation. The influence of various factors on the titration is discussed. For amounts of lanthanum, gadolinium, terbium, ytterbium, and yttrium varying from 3 to 9 μg, the method gives satisfactory results. It is also applicable to the determination of total rare earths. Calcium and magnesium do not interfere. With sulfosalicylic acid as masking agent, rare earths can be titrated in the presence of aluminum and chromium. Interferences by iron, copper, and manganese can be avoided by means of DDTC-$CHCl_3$ extraction. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 1, 1964)

7300 THE CHROMATOGRAPHIC SEPARATION, DETECTION AND DETERMINATION OF SCANDIUM. Shu-wei Pang, Chien-chuan Lei, and Shu-chuan Liang. Hua Hsueh Hsueh Pao, 30: 160-4(1964).

Using the eluent, ether-acetone-0.82 M NH_4SCN concentrated HCl (in the volume ratio of 150:150:4:3), all the R_F values of scandium and some other elements were found to be high, which might be explained by the difference in experimental conditions employed. The R_F values of scandium and lanthanum decreased gradually with the time of equilibration of paper strip in atmosphere of the eluent (from 0-4 hours). However, the difference in R_F values

of the two elements mentioned kept rather constant, with the eluent, it was possible to separate satisfactorily one part of scandium from 6000 parts of lanthanum into two separate spots, or to detect one part of scandium (spot with tailing) from 10,000 parts of lanthanum. The length of lanthanum spot increased with the amount of lanthanum present and became virtually constant when more than 7 mg was present. The sensitivity of fourteen reagents towards scandium was determined. The scandium spot could be determined chelatometrically after wet oxidation with mixed acid (equal volumes of concentrated hydrochloric, nitric, and perchloric acids). The buffered (pH 2.9) test solution was then titrated with 1×10^{-4} M EDTA with xylenol orange as indicator. Nine determinations of 1.00 μg of scandium gave an average of 1.003 ± 0.021 μg, with a standard deviation of 0.027 μg. A technique is also described for the separation of zirconium from uranium(VI), thorium, and rare earth metals (the latter three can not be separated from one another) on tributyl amine treated paper, and zirconium, uranium(VI)/thorium/rare earth metals may be separated into three spots as indicated on the other tertiary amines (C_5–C_9) treated paper. (TCO)

7301 PLASMOCHIN AS A REAGENT IN INORGANIC ANALYSIS. II. DETECTION OF CERIUM(IV), GOLD(III), AND VANADIUM(V). Nai-kuei Shen and Shue-hsiang Chin. Hua Hsueh Hsueh Pao, 30: 218-20(1964).

Plasmochin in the presence of 0.1N perchloric acid and 8% oxalic acid reacts with Ce(IV), Au(III), and V(V) to give a red-violet coloration that is insoluble in ordinary organic solvents (17 organic solvents were tested). The identification and concentration limits both on spot plate and in centrifuge tube were determined. The limits of proportion of Ce(IV), Au(III), and V(V) with 23 cations and 25 anions were determined and it revealed that in most cases they neither affect the reaction nor decrease the sensitivity even present in 1000-fold amounts. Procedures for the detection of Ce(IV), Au(III), and V(V) were devised, which are sensitive and highly selective. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 2, 1964)

7302 ON THE SEPARATION OF RARE EARTH ELEMENTS BY REVERSED-PHASE PAPER CHROMATOGRAPHY. II. THE HDEHP–OXALIC ACID SYSTEM. Shu-Wei Pang and Shu-Chuan Liang. Hua Hsueh Hsueh Pao, 30: 237-40(1964).

The reversed-phase paper chromatographic separation of rare earth elements, thorium, and uranium was investigated. Di(2-ethylhexyl)–phosphoric acid (HDEHPO) dissolved in toluene was applied to Whatman No. 1 paper, and subsequently, the solvent was driven off with hot air current. The ions studied were applied onto the paper and eluted with various concentrations of oxalic acid (0.1–1.0M). The cerite earths (except lanthanum), ytterbium earths, and yttrium moved very slightly (R_F 0–0.02), and terbium earths and scandium remained on the original spot. Erbium earths, lanthanum, and uranium moved a little. Thorium moved considerably and its R_F value increased with increasing concentration of oxalic acid, while it remained on the original spot in the HDEHP-hydrochloric acid system. From the R_F values found, it was possible to separate thorium from uranium and/or rare earths with the HDEHP-oxalic acid system. Using 0.5M oxalic acid as eluent, the separation factors as calculated from R_F values found were 21 and 5 for uranium/thorium and rare earth/thorium pairs, respectively. The effect of temperature, from 10 to 50°C, on values of lanthanum and dysprosium was slight, and became somewhat more pronounced in the case of thorium, but their relative changes in R_F values were nearly the same. The amount of HDEHP in the paper strips also affected the R_F values. On increasing the amount of HDEHP in the strips, the R_F value tended to decrease. This phenomenon was more distinct in the case of thorium than in the cases of lanthanum and dysprosium. (Sci. Abstr. China, Chem. Chem. Technol., 2: No. 2, 1964)

7303 ABSORPTION OF $C^{14}O_2$ FROM A GAS STREAM AND PREPARATION OF $BaC^{14}O_3$ PRECIPITATES FOR COUNTING WITH G-M TUBES. M. Yamaguchi, D. L. Hughes, F. D. Howard (Univ. of California, Davis). Intern. J. Appl. Radiation Isotopes, 15: 545-9(Sept. 1964).

A tube for absorption of $^{14}CO_2$ from small volumes of gases, an apparatus for periodic sampling of $^{14}CO_2$ automatically from a flowing stream, and a method for quantitatively collecting and counting small quantities of $Ba^{14}CO_3$ precipitates are described. (M.C.G.)

7304 LITHIUM ALUMINUM TRITIDE IN ACTIVE HYDROGEN ANALYSIS. W. Seaman and D. Stewart, Jr. (American Cyanamid Co., Bound Brook, N. J.). Intern. J. Appl. Radiation Isotopes, 15: 565-7(Sept. 1964).

Use of lithium aluminum tritide for analysis of organic compounds for active hydrogens is discussed. Effects of sample composition on the degree of liberation of tritium are described. (M.C.G.)

7305 LITHIUM ALUMINUM TRITIDE IN ACTIVE HYDROGEN ANALYSIS. D. Chleck, F. J. Brousaides, and C. A. Ziegler (Parametrics Inc., Waltham, Mass.). Intern. J. Appl. Radiation Isotopes, 15: 627(Oct. 1964).

Studies on the use of 4 calibration curves, with the same specific activity of lithium aluminum tritide, for determining the active hydrogen content of an unknown are discussed. The importance of adequate degassing is emphasized. (M.C.G.)

7306 THE NATIONAL BUREAU OF STANDARDS TRITIATED WATER STANDARDS. W. B. Mann (National Bureau of Standards, Washington, D. C.) and A. Spernol. Intern. J. Appl. Radiation Isotopes, 15: 628(Oct. 1964).

Two independent measurements, using gas counting, of the National Bureau of Standards 1954 tritiated water standards, are compared. The agreement was about 0.25%, which was within their stated precisions. (M.C.G.)

7307 DIRECT SPECTROCHEMICAL DETERMINATION OF SOME RARE EARTH ELEMENTS IN URANIUM. Irena Schoenfeld (Soreq Research Establishment, Nahal Soreq, Israel). Israel J. Chem., 2: 99-104(Aug. 1964).

A spectrochemical method for analysis of uranium for samarium and europium, without prior separation, is presented. The method is based on excitation of uranium in the chloride form with potassium chloride as buffer and by use of 4A d-c arc excitation. Under these conditions it was possible to overcome the difficulties arising from the complex spectrum and heavy background of uranium. The limits of detection for europium and samarium were 5 and 20 ppm, respectively; the coefficient of variation for Eu and Sm was about 25% for a single determination. The visually established limit of detection for gadolinium and dysprosium was 50 ppm. (auth)

7308 SPECTROGRAPHIC METHOD FOR QUANTITATIVE DETERMINATION OF SCANDIUM IN SULFURIC ACID SOLUTIONS. T. P. Taskaeva (Inst. of Chemistry and Metallurgy, Academy of Sciences, Siberian SSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 148-50(1964). (In Russian)

A spectrographic method was developed for determining Sc in solutions of varying H_2SO_4 concentration. The sensitivity for Sc is 2×10^{-3} mg/ml. The reproducibility of the measurements is ±5 relative % and the precision is ±8.3 relative %. (IIC-M.G.)

7309 DETERMINATION OF BROMINE AND IODINE IN SODIUM GLUTAMATE BY NEUTRON ACTIVATION ANALYSIS. Hwa-Sheng Cheng, Chiung-Huei Ke, and Ching-Yu Lin (National Tsing Hua Univ., Taiwan, China). J. Chinese Chem. Soc. (Taiwan), 10: 92-100(Sept. 1963).

The contents of Br and I in commercial sodium glutamate and cassava flour were determined by neutron activation analysis. The conventional carbon tetrachloride extraction method was employed for the analysis of these elements. Samples and standards were enclosed in a polyethylene capsule, and irradiated at a neutron flux of 10^{12} n/cm²/sec for 20 min in a swimming-pool type reactor. The decay curve of radiobromine consisted of ^{80m}Br and ^{80}Br. The 4.5-hr ^{80m}Br was removed from the total decay curve to obtain 18-min ^{80}Br decay curve. All the activities of ^{80}Br and ^{128}I at a given time could be found from their decay curves. The halogen content was calculated from

the activity and the chemical yield of the sample and the standard. The calculated chemical yields were between 50 and 70% for both elements, except in the case of Br where 11% and 26% were obtained for two glutamate samples. The effect of self-absorption was not a serious problem since the energy of radiation from ^{80}Br is high (2 Mev). It was found that the content of Br varied widely between 0.003 and 0.1 ppM, while that of I varied between 0.06 and 0.7 ppM, in six samples of sodium glutamate. Two samples of cassava flour were found to contain 0.1 and 0.2 ppM of Br, and 0.02 and 0.04 ppM of I, respectively. The higher contents of these elements in some glutamate samples as compared with the raw material were considered to be the contamination from chemicals used in the production processes. (BBB)

7310 COLORIMETRIC IDENTIFICATION FOLLOWING TRITIUM RECOVERY FROM PAPER. J. L. Spratt (State Univ. of Iowa, Iowa City). J. Chromatog., 16: 253(Oct. 1964).

To assure quantitative recovery of tritium-labeled compounds from paper chromatograms by eluting the material from the paper, glycoside color reagents were used. They were found to markedly quench counts and/or decrease extraction of the materials from the developed chromatogram. Therefore, the chromatogram was cut into thin strips and each section quantitatively extracted, counted, and corrected for quench by internal standardization. The color reagent was then added to verify location of carrier compounds. (M.C.G.)

7311 DETERMINING THE OXYGEN CONTENT OF STEEL BY NEUTRON ACTIVATION TECHNIQUES. F. C. Burns (Army Materials Research Agency, Watertown, Mass.). J. Metals, 16: 948(Dec. 1964).

A fast neutron activation technique was developed for determining the elemental oxygen in steel samples. With this method, large, representative samples of steel can be analyzed in as little time as 1 min. Since samples are tested nondestructively, it is a simple matter to check the results of a reading either immediately or at a later time. The accuracy and repeatability of the technique depend on the oxygen content of the sample. If the oxygen concentration is only 10 ppm, accuracy of ±25% and repeatability of ±20% can be expected. However, if the concentration is 500 ppm, accuracy of ±5% and repeatability of ±1% are obtained. (P.C.H.)

7312 AN IMPROVED COLLIMATOR FOR SINGLE-CRYSTAL X-RAY DIFFRACTION WORK. Hilda Cid-Dresdner and M. J. Buerger (Massachusetts Inst. of Tech., Cambridge). J. Sci. Instr., 41: 689-91(Nov. 1964).

A collimator system consisting of a borehole in a solid aluminum rod is proposed for use in single-crystal x-ray diffraction work. Such a collimator is free from the fluorescent-scattering characteristic of the usual lead-pinhole systems and therefore ensures a lower background for reflections of small sin θ values. (auth)

7313 A WELL SAMPLE CHANGER TO BE USED WITH AN AUTOMATIC DISH SAMPLE CHANGER. R. A. Krause (Rudolf-Virchow-Krankenhauses, Berlin). Kerntechnik, 6: 467-8(Oct. 1964). (In German)

An automatic well sample changer was developed by an addition of a part to a proven sample changer for 1-in. samples. The construction of a simple travelling crane to carry test glasses from a sample changer turntable into a well type scintillation counter is described. The unit is programmed for continuous cycling of samples. Wiring diagrams are reproduced. (auth)

7314 THE RAPID RADIOCHEMICAL DETERMINATION OF IODINE-131 IN LIQUID MILK. Kiyoshi Iwashima and Noboru Yamagata (Inst. of Public Health, Tokyo). Koshu Eiseiin Kenkyu Hokoku, 13: 126-7(1964).

A method is described for the rapid radiochemical determination of ^{131}I in fresh cow milk containing more than 10 $\mu\mu$C/l. The first step is separation of iodine by a strong base anion exchanger, the second is elution with sodium perchlorate solution, the third is precipitation as silver iodide, and finally the activity is measured by a low-background beta counter. The recovery of iodide-iodine in milk was almost complete and decontamination from other radioisotopes was satisfactory. Two hours were required for the complete processing before the counting. (auth)

7315 A SIMPLE MASS SPECTROMETER FOR THE ANALYSIS OF ARGON AT ULTRA-HIGH VACUUM. E. Farrar, R. M. Macintryre, Derek York, and W. J. Kenyon (Toronto Univ.). Nature, 204: 531-3(Nov. 7, 1964).

A mass spectrometer for use in potassium-argon dating for isotopic dilution determination of argon is described. The instrument uses a 2-in. radius of curvature with 180° deflection. A magnetic field of 1830 gauss is produced by the small permanent magnet and electrostatic scanning of the various ion beams is brought about by a motor-driven potentiometer in the source controls. Use of the static method in mass spectrometry was found to produce a great increase in sensitivity over the more usual dynamic mode. The method used and its accuracy are discussed. (M.C.G.)

7316 DETERMINATION OF CARBON IN STEELS BY MEASUREMENT OF THE PROMPT γ-RADIATION EMITTED DURING PROTON BOMBARDMENT. T. B. Pierce, P. F. Peck, and W. M. Henry (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 204: 571-2 (Nov. 7, 1964).

The determination of carbon in steel by means of prompt gamma radiation from the $^{12}C(p,\gamma)^{13}N$ reaction is reported. Targets were irradiated to a dose of 25,000 μC using 0.8-Mev protons. Counts under the 2.3-Mev prompt gamma peak were plotted against the known carbon content of the steels. Agreements with spectrographic analyses were good. (M.C.G.)

7317 ^{235}U ENRICHMENT DETERMINATION OF LOW ENRICHED UO_2 POWDER BY GAMMA SCINTILLATION SPECTROMETRY. Hideo Yamaki (Hitachi Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 6: 632-7(Nov. 1964). (In Japanese)

Gamma scintillation spectrometry is known as a rapid and nondestructive method for determination of ^{235}U enrichment. The method of the comparison of the ratio of the relative intensities of 184 kev from ^{235}U to 90 kev from ^{238}U daughters is more accurate and sensitive for low enrichment than the method of the intensity of 184 kev alone. The relationship between the enrichment and the peak ratio, which includes the correction of the experimental condition, was obtained by considering the U disintegration schemes and the data of the two standard samples. Enrichments of 2.5% and 1.5% enriched U samples were determined by this relation. The results show good agreement with the values determined by the supplier of these materials. (auth)

7318 NEUTRON ACTIVATION ANALYSIS OF ARSENIC IN THE HARD TISSUES OF THE ARSENIC DEVITALIZED TEETH. Eiko Sairenji, Yukimichi Urata, Toshinori Suzuki, Emiko Sasaki, Hiroshi Toriumi, and Toshimi Otski. Nippon Univ. J. Radiation Med. Biol., 1: 13-16(Mar. 1963). (In Japanese)

The determination of arsenic in human teeth was carried out by means of neutron activation analysis. Tooth samples, together with arsenic standard, were irradiated from 2 to 15 hours with thermal neutrons, flux of about 10^{11}n/cm^2/sec. In order to prevent other radioactive contaminations, radiochemical separation was done. Arsenic in tooth samples together with the known amount of carrier arsenic were distilled from concentrated hydrochloric acid solution as the trichloride. The chemical yield of the carrier in each separation was determined, afterwards, through the titration with potassium bromide solution. Counting was performed in gamma counting by single channel gamma ray pulse height analyser with NaI (Tl) well-type crystal ($1\frac{3}{4} \times 2$ in.; hole $\frac{3}{4} \times 1\frac{1}{2}$ in.). As a result, it was found that the arsenic concentrations in the arsenic devitalized human teeth are much greater than that in the control teeth (not-devitalized). The arsenic that migrated into the tooth remained in that part for a long period of time, though it gradually decreased in amount. The arsenic amount in the tooth of 18 years after the arsenic pulp-devitalization was 3.14 μg (2.36 μg/g of tooth). Reactions, which are possible for forming ra-

dioactive arsenic nuclides in a nuclear reactor other than ^{75}As (n, γ) ^{76}As reaction, are discussed. (auth)

7319 TRACE ELEMENTS IN BIOMEDICAL RESEARCH. J. M. A. Lenihan (Western Regional Hospital Board, Glasgow). Nucleonics, 23: No. 1, 50-2(Jan. 1965).

The measurement of trace elements in the body, with special reference to activation analysis, is discussed. Advantages of the activation analysis technique are given. (P.C.H.)

7320 RECENT USES OF LIQUID ION EXCHANGERS IN INORGANIC ANALYSIS. H. Green (British Cast Iron Research Assn., Birmingham, Eng.). Talanta, 11: 1561-80 (Dec. 1964).

A review of recent uses of liquid ion exchangers in inorganic analysis is presented. (59 references). (auth)

7321 GRAVIMETRIC ANALYSIS OF TANTALOCOLUMBITES BY PRECIPITATION FROM HOMOGENEOUS SOLUTION. R. Dams and J. Hoste (Universiteit, Ghent). Talanta, 11: 1605-12(Dec. 1964).

An analysis of complex tantaloniobites was carried out by precipitation from homogeneous solutions. A homogeneous precipitation of tungsten, titanium, tantalum, and niobium by thermal decomposition of the soluble peroxytungstates was used. Corrections for incomplete precipitation and coprecipitation phenomena were applied on the basis of experimentally found values. Silicon and tin were separated by volatilization as fluoride and iodide, respectively. Iron was extracted by means of isopropyl ether and the rare earth metals were precipitated homogeneously from an oxalate solution. Manganese was precipitated as the ammonium phosphate. The results were in good agreement with an independent method. The standard deviations were within 1% for the major constituents. (auth)

7322 DETERMINATION OF BERYLLIUM BY MEANS OF HEXAMMINECOBALT(III) CARBONATOBERYLLATE. I. COMPOSITION OF THE PRECIPITATE AND ITS SUITABILITY AS A WEIGHING FORM FOR BERYLLIUM. R. G. Monk and K. A. Exelby (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Talanta, 11: 1633-9 (Dec. 1964).

The precipitate obtained when hexamminecobalt(III) chloride was added to a solution of beryllium in excess ammonium carbonate was analyzed and its behavior under different humidity conditions examined. The composition was that of hexamminecobalt(III) hexacarbonato-oxo-tetraberyllate $[Co(NH_3)_6]_2[Be_4O(CO_3)_6] \cdot xH_2O$, as suggested by Sen Gupta, rather than that of Pirtea $[Co(NH_3)_6][(H_2O)_2Be_2(CO_3)_2(OH)_3] \cdot 3H_2O$. It was found that x depends on humidity. It varied between 10.8 and 11.1 at relative humidities between 32 and 80%. Drying the precipitate in vacuo over anhydrous magnesium perchlorate or phosphorus pentoxide resulted in 3 molecules of water being retained. The compound as normally precipitated may be a mixture of the deca- and dodecahydrates that Sen Gupta prepared. After conditioning at a definite humidify and if an empirical factor is used, the precipitate may be suitable as a gravimetric form for determining beryllium where precision requirements are not too exacting. (auth)

7323 RAPID ESTIMATION OF RADIOACTIVE TELLURIUM IN ^{131}I-PREPARATIONS. Leo Kronrad and Jiri Cifka (Inst. for Nuclear Research, Prague). Z. Anal. Chem., 196: 407-12(1963). (In German)

Iodine-131 is obtained from an irradiated TeO_2 target by distillation. Several radioisotopes of Te are present in targets of this type, but the major contaminant is ^{125m}Te. The ^{131}I is coprecipitated on HgCl in alkaline solution, and the Te radioisotopes are coprecipitated on HgCl in acid solution. The γ activity of the Te in the precipitates is measured by a spectrometer and a combination of two probes, one a NaI crystal and the other an anthracene crystal. The measurement results from the two crystals are subtracted from each other, and the differences are plotted to give a curve free of Compton electron activity. The value obtained must be corrected for losses that occur during the analysis, by comparison with the Te concentration of the original solution. (BBB)

7324 THE USE OF FORMAZANS IN ANALYTICAL CHEMISTRY. COMMUNICATION 4. DETERMINATION OF YTTRIUM WITH N,N′-DI-(2-HYDROXY-5-SULPHOPHENYL)-C-CYANFORMAZAN. N. L. Vasilieva and M. I. Ermakova (Inst. of Chemistry, Academy of Sciences, Sverdlovsk, USSR). Zh. Analit. Khim., 19: 1305-8(1964). (In Russian)

A method was developed for the photometric determination of yttrium using N,N′-bis(2-hydroxy-5-sulfophenyl)-C-cyanformazan. The method permits determination of 5.0 to 10% of yttrium in lanthanum oxide without separation. The sensitivity of the determination is 0.56 μg/ml of yttrium. (auth)

7325 THE USE OF POLYPHENOL DERIVATIVES FOR INCREASING THE SENSITIVITY OF THE SPECTROPHOTOMETRIC DETERMINATION OF CERTAIN RARE EARTHS. K. V. Tserkasevich and N. S. Poluektov (Inst. of General and Inorganic Chemistry, Odessa, Ukrainian SSR). Zh. Analit. Khim., 19: 1309-14(1964). (In Russian)

The sensitivity of spectrophotometric determinations of lanthanides (Pr, Nd, Sm, Ho, Er) can be increased 1.6 to 16 times when they are determined as solutions of complexes with tiron (sodium pyrocatechol disulfonate) in an alkaline medium. Thus less amounts of the analyzed material are needed. (auth)

7326 THE USE OF BENZENESULFINIC ACID FOR PLUTONIUM DETERMINATION. M. S. Milyukova. Zh. Analit. Khim., 19: 1326-31(1964). (In Russian)

In the interaction of Pu(IV) with benzenesulfinic acid in an acid medium a precipitate of $Pu(C_6H_5SO_2)_4$ is formed. The solubility of $Pu(C_6H_5SO_2)_4$ under the conditions of the quantitative plutonium precipitation was found to be equal to 2.8 to 3 mg/l or $(1.17 \text{ to } 1.25) \times 10^{-5}$M. The effect of various factors on plutonium precipitation was studied and optimum conditions for quantitative separation of plutonium as benzenesulfinate were established. The extraction of plutonium(IV) benzenesulfinate with organic solvents was studied. The effects of concentrations of nitric acid, sodium benzenesulfinate, and plutonium on the distribution coefficient were investigated. (auth)

7327 RADIOCHEMICAL DETERMINATION OF Sr^{89}, Sr^{90}, AND Ba^{140} IN NUCLEAR DEBRIS. Howard Lawrence Hodges. Thesis, Little Rock, Ark., Univ. of Arkansas, 1964. 111p.

A radiochemical method is presented, which is suitable for the analysis of ^{89}Sr, ^{90}Sr, and ^{140}Ba regardless of the relative concentrations of these constituents in a rainwater sample. The procedure employs nonisotopic carriers of strontium and barium to aid in the separation and in the chemical yield determinations. The Willard-Goodspeed nitric acid precipitation is used to remove the strontium and barium from the fission-product mixture. The barium is then separated from the strontium by a barium chromate precipitation. The use of holdback carriers and several ferric hydroxide scavenging procedures facilitate the further decontamination of the desired nuclides. Finally the strontium and barium are precipitated as the respective carbonates for counting. The precision of the method is found to be 90 percent or greater at the 95-percent confidence level. Geochemical consideration of the phenomenon of chemical fractionation of isotopes in the atmosphere is presented. This phenomenon is discussed in light of the relative fractionation of ^{89}Sr and ^{90}Sr bomb-debris activities as measured in rainfall analyses. A mechanism is outlined whereby these isotopes may be selectively fractionated relative to each other. Data are presented showing the isotope ratio variations of $^{89}Sr/^{90}Sr$ within a single rain. The long holdup in the stratosphere of radioactive material produced by the very-high-altitude nuclear detonations (in excess of 100,000 feet) is also shown. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7328 THE PROPERTIES OF SILICA GEL AS ION EXCHANGER AND STUDIES OF THE SEPARATION OF Pb^{212}, Bi^{212}, AND Tl^{208}. W. Bannasch. Thesis, Karlsruhe, Ger., Technische Hochschule, 1964. 94p. $2.00(Gmelin, AEDDISS. 64-34). (In German)

The extraction of ions from aqueous solutions by silica

gel was studied for the following cations: Na^+, K^+, Cs^+, (^{137}Cs), Tl^+/Tl^{3+} (^{208}Tl), Pb^{2+} (^{212}Pb), and Bi^{3+} (^{212}Bi and ^{210}Bi). CrO_4^{2-} (^{51}Cr) and I^- (^{131}I) were used as anions. The isoelectric point of silica gel corresponds to a p_H 3. For a $p_H < 3$ silica gel interacts with anions. Relative transport velocities for various acids concentrations are given. For a $p_H > 0$ silica gel acts as cation exchanger. Using a suitable p_H the separation of $^{212}Pb + ^{208}Tl$ from ^{212}Bi and ^{208}Tl from ^{212}Bi is possible. A ^{208}Tl generator by elution of this isotope is described. (Gmelin Inst.)

7329 METHODS OF CHEMICAL ASSAY OF CALCIUM. p.163-8 of STI/DOC/10/32.

Methods used by panel participants for chemical assay of calcium are presented. (H.M.G.)

7330 CHEMICAL DETERMINATION OF CALCIUM IN URINE; RESULTS OF INTERLABORATORY COMPARISON, 1964. N. Veall. p.185-8 of STI/DOC/10/32.

Following the first Panel on Medical Applications of ^{47}Ca in 1961 samples of urine were sent to a number of the participants for chemical calcium determinations. There were often considerable discrepancies between the results from different laboratories and in some cases there were similar internal discrepancies. At the second ^{47}Ca Panel in 1963 a further interlaboratory comparison was arranged and the results subsequently obtained are presented. (auth)

7331 TRACE ANALYSIS BY CHEMICAL AND ELECTROCHEMICAL STRIPPING. Harold Arthur Vincent. Thesis, Tucson, Ariz., Univ. of Arizona, 1964. 206p.

A new trace analytical method is described. The basis for the method is that the rate of oxidation of an amalgam drop electrode under open circuit conditions is dependent on the rate of mass transfer of the oxidant to the electrode surface. The rate of mass transfer under constant stirring conditions is dependent upon the bulk solution concentration of the oxidant. The time necessary for the chemical stripping process to be complete for a particular amalgam is usually the same as the anodic "transition time" from the potential-time curve measured after the electrolytic circuit has been opened. Instrumentation was developed to measure automatically the transition times and eliminate subjective evaluation by using preset voltage trigger levels for the beginning and ending of the transition time with an electronic counter providing the time readout. Uranyl ion was used to elucidate the experimental parameters for the method in general. Application was made in 0.1 molar potassium chloride solutions to the determination of europium(III) by means of its reaction with the zinc amalgam drop electrode. Determinations can be made in the 10^{-4} to 10^{-7} molar concentration region with a standard deviation for a single run at ±0.2 unit of logarithm of concentration of europium. The lower limit for this technique is due to the reaction of reducible solution impurities, including dissolved oxygen. The upper limit results from a competitive electrochemical poising process. Attempts to apply this technique to the determination of ytterbium and samarium by using sodium and lithium amalgams in N,N-dimethylformamide (DMF) solutions were unsuccessful. The quantitative determination of small quantities of alkali metals in DMF solutions by the method of linear scan voltammetric stripping was developed. From the exchange current density data for the zinc-amalgam electrode system and from experiments with trace solutions of zinc, the limiting sensitivity for the zinc determination by the current-step stripping method was calculated. (A.G.W.)

7332 THE PLACE OF RADIOCHEMICAL METHODS OF ANALYSIS–TODAY AND TOMORROW. W. Wayne Meinke (National Bureau of Standards, Washington, D. C.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/102, 10p. (CONF-641001-40)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria, Oct. 1964.

A review is presented on developments and future trends in radiochemical analysis. It is stated that many of the major developments in the future will be in high purity and trace analysis. Another consideration for the future involves nondestructive analysis. (P.C.H.)

7333 TWO RADIOMETRIC METHODS FOR RAPID TUNGSTEN DETERMINATION IN TOOL STEEL. L. Gőrski and A. Lubecki (Inst. of Radioisotopes Techniques, Academy of Mining and Metallurgy, Krakow). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/94, 19p. (CONF-641001-38)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Two radiometric methods that can be combined for determining tungsten in tool steel in the whole range of interest, i.e. 0–20% of tungsten, are described. The average time of determination is about 1–5 minutes. The first method is based on non-dispersive x-ray fluorescence excited by a radioisotope bremsstrahlung source. The method is particularly suitable for tungsten contents between 0 and 11%. For higher contents the accuracy of this method is lower than that of the second one. The second method is based on the backscattering of beta rays, and is suitable for tungsten contents between 9 and 20%. The apparatus applied in both methods is essentially the same and consists of a conventional single-channel pulse spectrometer with a NaI(Tl) thin crystal for x rays or a plastic scintillator for beta rays. X rays for excitation are obtained from a 150 mC source $^{90}Sr + ^{90}Y/Pb$. In the backscattering method of 0.4 mC $^{90}Sr + ^{90}Y$/beta source is used alternatively. Detailed geometry and the experimental procedure are described. The main problem in the work was the choice of the most suitable standardization procedure, so that perfect repeatability of results independent of electronic drifts would be obtained. It was found that for obtaining correct results it is sufficient to use samples with only roughly ground surfaces. No thermal treatment of samples was necessary. The relative errors of the method were determined by statistical analysis of the results from subsequent determinations. They are (± one standard deviation) about ± 1.6% for 1% content of tungsten, and ± 1.1 to ± 1.3% in the range from 4–18% for the fluorescence method; and about ± 0.9% for tungsten contents between 16 and 20% for the backscattering method. (P.C.H.)

7334 SUBSTOICHIOMETRY IN ACTIVATION ANALYSIS AND ISOTOPE DILUTION AND ITS USE FOR DETERMINATION OF TRACES OF IRON. J. Růžička, A. Zeman, and J. Starý (Univ. of Prague). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/85, 12p. (CONF-641001-48)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A substoichiometric procedure for the determination of traces of iron by activation analysis is described and the experimental results obtained are discussed. The proposed procedure was used for determination of iron in various materials. The substoichiometric principle permits considerable simplification of the radiochemical separation procedures used in activation analysis, which is advantageous especially in the case of routine work. When analysis is performed, to the irradiated analyzed sample and to the irradiated standard sample exactly the same (milligram) amount of iron as isotopic carrier is added. The radiochemical procedure is based on the use of the substoichiometric amount of chelating agent (cupferron) and the iron-III-cupferrate is separated by solvent extraction with chloroform. As the amount of cupferron added to the analyzed and standard sample is exactly equal, the necessity of determining the chemical yield is avoided. The amount of iron present in the analyzed sample (y) is calculated from the relation $y = y_s(a/a_s)$ where y_s = the amount of iron present in the irradiated standard sample, a, a_s = activities of the organic extracts obtained from the analyzed standard sample respectively. From the theory of substoichiometry it follows that by using the suitable reagent the selectivity of radiochemical separation can be highly increased and the analytical procedure substantially simplified. The optimum conditions for substoichiometric determination of 24 metallic elements are briefly discussed. Also the determination of traces of iron by isotopic dilution analysis using the substoichiometric principle is considered. (auth)

7335 THE USE OF AN ELECTRONIC COMPUTER IN DETERMINING SODIUM, CHLORINE, MANGANESE AND COPPER IN TERPHENYLS BY ACTIVATION. G. Aubouin, E. Junod, and J. Laverlochere (Centre d'Etudes Nucléaires, Grenoble, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/70, 21p. (CONF-641001-37)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Following several years' experience of routine determination by neutron activation of the elements sodium, chlorine, manganese and copper in terphenyls, the use of a CAB 500 computer to industrialize this measuring operation was investigated. In order to make the operation a routine one, standard procedures (sampling, irradiation, counting, verification) were employed. Groups of four samples were analyzed with an automated gamma spectrometer. In analyzing the measurements the least squares method was used and was applied to elements showing the following figures (in Mev) for energy interference: $^{24}Na-1.38$ and 2.75; $^{38}Cl-1.64$ and 2.15; $^{56}Mn-0.85$ and 2.12; and $^{64}Cu-0.51$ and 1.34. In addition the organic matrix caused ^{13}N to be formed during irradiation (gamma energy 0.51 Mev). To test this method three separate measuring, and hence computing, programs were written with a particular view to establishing safe procedures permitting cross-checking and other controls. The main constituents of the computer program are: standardization of control spectra; least square analysis; standardization of the isolated components thus obtained; corrections for radioactive decay; calculation of the masses of the impurities; value of the standard deviation for each result. (P.C.H.)

7336 STUDY OF THE WATER CONTENT OF IRON ORES BY THE SLOWING-DOWN OF NEUTRONS. A. Kohn (Institut de Recherches de la Sidérurgie, St. Germain-en-Lage, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/78, 20p. (CONF-641001-31) (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A study was made on the sensitivity of a method for estimating the moisture content of iron ores. The study was based on the idea that fast neutrons emitted by a small source incorporated in the measuring probe are slowed down by the hydrogen atoms of water. The first step was to define experimentally the nature of the factors that have an effect on the slowing down and back-scattering of fast neutrons, these being the physical phenomena involved in the method of analysis in question. Next tests were carried out on various ores and mixtures for sintering, by placing the measuring probe inside a barrel containing a sample of about 400 kg of the product under study. This sample was subjected to successive moistenings in conditions such that the water was distributed as homogeneously as possible. The content by weight of water as estimated by the apparatus (ratio between the slow neutron counting rate and the mean density of the sample) was compared to the total water content measured chemically; the results showed that: for a given product there is a practically linear relationship between these two quantities within the range of moisture contents investigated; the slope of this line depends on the chemical composition of the ore; in the ore-fines mixtures studied, the slope of the line does not depend on the respective proportions of these two constituents; and the addition of coke to the mixture slightly increases the slope of the line. (P.C.H.)

7337 QUANTITATIVE DETERMINATION OF CALCIUM, SILICON, SULPHUR, AND PHOSPHORUS IN NUCLEAR GRAPHITES BY ACTIVATION ANALYSIS. S. May and D. Piccot (Centre d'Etudes Nucléaires, Saclay, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/75, 19p. (CONF-641001-29). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The elements Ca, Si, P, and S lead by neutronic activation to radioelements either short-lived or pure β emitters. The difficulty of the method is to put in solution the graphite matrix which presents the advantage not to be activable by irradiation. All the determinations were done by chemical separations and carrier techniques. (auth)

7338 USE OF PAPER CHROMATOGRAPHY AND COMPUTERS IN NEUTRON ACTIVATION: APPLICATION TO ROUTINE QUANTITATIVE ANALYSIS OF TRACE ELEMENTS IN GEOLOGIC MATERIALS. R. Coulomb and J. C. Schiltz (Centre d'Etudes Nucléaires, Fontenay aux Roses, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/98, 18p. (CONF-641001-53). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Owing to the combination of extremely simple and quick separations by paper chromatography and the exploitation of γ spectra by computers, routine analyses of numerous varied elements in rocks and minerals (particularly: Sc, Ta, Th, U, Ca, Mn, Cu, W, Co, Rb) were carried out without difficulty and rather cheaply. A few typical examples and the FORTRAN programs used are given. (auth)

7339 DETERMINATION OF OXYGEN, CARBON, NITROGEN AND CERTAIN OTHER IMPURITIES IN BERYLLIUM, CALCIUM, SODIUM AND BORON BY GAMMA-RAY ACTIVATION. Ch. Engelmann (Centre d'Etudes Nucléaires, Saclay, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/69, 26p. (CONF-641001-52). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A linear accelerator yielding electrons with a maximum energy of 28 Mev was specially fitted out for activation analysis. A complete study of the effect of the energy of the incident particles and of the thickness of the targets made it possible to develop ultrasensitive methods of analysis. Since completely automatic counting devices are used, determination of most of the impurities is non-destructive. With materials of very high purity sensitivities of 1 to 0.01 ppm by weight were genuinely obtained. Various nuclear reactions that create interference were studied and a description is given of methods of irradiation at several nominal energies which make it possible to distinguish activation by interfering impurities. (auth)

7340 THE APPLICATION OF 14 Mev NEUTRON ACTIVATION ANALYSIS TO THE MEASUREMENT OF ADDITIVES IN LUBRICATING OIL. D. Gibbons, W. J. McCabe, and G. Olive (Wantage Research Lab., Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/19, 30p. (CONF-641001-43)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The measurement of additives in lubricating oil was investigated as a typical industrial application of 14 Mev neutron generator activation analysis. Barium and phosphorus were determined in the concentration ranges 0.05–2.0 and 0.01–1.0% respectively, using non-destructive gamma spectrometry. The method was extended to the measurement of iron, sulfur, and chlorine down to concentrations of 0.01, 1.0, and 0.05%, respectively. The measurement of copper and zinc was also investigated, but resolution of multicomponent decay curves was necessary in addition to gamma spectrometry. The precision of the measurements was evaluated considering both statistical and other errors, and the need for a universally acceptable set of criteria for realistic estimates of sensitivity is discussed. (P.C.H.)

7341 DETERMINATION OF O^{18} CONTENTS OF HYDROGEN-CONTAINING SUBSTANCES BY IRRADIATION WITH NEUTRONS. D. C. Aumann and H. J. Born (Technische Hochschule, Munich). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/38, 21p. (CONF-641001-51)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Backscattering protons from the n,p collision of fast neutrons in water containing substances cause the reaction $^{18}O(p,n)^{18}F$. The resulting fluorine-18, which has a half life of 112 minutes, is a measure for the content of oxygen-18. The fluorine is measured in a coincidence device. No

chemical pretreatment of the reaction products is necessary. Using a flux of fast neutrons of 8.7×10^{10} n/cm^2 sec (3.5 Mev) an activity of 8 μCi of fluorine-18 per gram of $H_2{}^{18}O$ can be obtained by irradiation, until saturation is reached. (auth)

7342 THE DESIGN AND USE OF AN ADVANCED, INTEGRATED AUTOMATIC SYSTEM AND COMPUTER PROGRAM FOR NUCLEAR ACTIVATION ANALYSIS. R. E. Wainerdi (Agricultural and Mechanical Univ., of Texas, College Station), L. E. Fite, D. Gibbons, W. W. Wilkins, P. Jimenez, and D. Drew. Vienna, International Atomic Energy Agency, 1964. 18p. (CONF-641001-17)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A high speed, automated nuclear activation analysis system was constructed and used for the analyses of samples whose minor compositional variations are of research interest, and whose constituents are amenable to instrumental nuclear activation analysis. The Mark II Automatic System produces gamma spectrometric data in proper format for reduction by the AA-6 computer program, following the bulk, or sequential, activation of samples in a reactor, a cyclotron, a 14 Mev generator, or other activating source. The Mark II System consists of three matched 4 in. diameter by 4 in. high NaI(Tl) well crystals, three 400 channel analyzers, a pneumatic transfer system, two sample storage libraries, three drift stabilization circuits, a system control unit, a binary clock, a coding device, a three path high speed memory to magnetic tape coupler, and components of an IBM-704 computer. The AA-6 computer program utilizes the data provided by the Mark II System, including sample number, crystal code, 400 channels of spectral information, and appropriate times. The digital computer matches library information for the various probable constituents with spectral information about each sample to determine qualitative and quantitative analyses by means of least squares curve fitting and quadratic programming. The operating time of the AA-6 computer program is 4 seconds per sample, using a 32,000 word IBM-709 digital computer. Data from the initial operations of the Mark II System and AA-6 program, including repetitive analyses of the same sample, and tests of the applicability of the automated, computer coupled approach to instrumental activation analysis problems, are presented, together with cost information. (P.C.H.)

7343 RADIOACTIVE KRYPTONATES: A NEW TOOL FOR ANALYSIS AND MEASUREMENT. D. Chleck (Parametrics Inc., Waltham, Mass.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/41, 21p. (CONF-641001-49)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The properties of radioactive kryptonates for chemical analyses and measurements are discussed. Methods for using solid ^{85}Kr are described. Two examples are given. The analysis of hydrogen gas by reduction of metal oxides in an air and nitrogen medium is described. Also outlined is the sensitive analysis of fluoride ion in solution by means of a kryptonate indicator. The analytical measurements have been made over large concentration and temperature ranges allowing an analysis of the reaction kinetics with correlation to mechanism. (P.C.H.)

7344 THE PRESENCE AND EFFECT OF ISOTOPE FRACTIONATION IN ISOTOPE DILUTION ANALYSIS: A FACTOR IN THE MEASUREMENT OF ALDOSTERONE SECRETORY RATES IN MAN. J. H. Laragh, J. E. Sealey, and P. D. Dlein (Columbia Univ., New York and Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/44, 29p. (CONF-641001-46)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The effect of various amounts of unlabelled aldosterone diacetate in the absence of constant isotope ratio and the relative contributions of the ^{3}H and ^{14}C label to the isotopic fractionation effect were investigated. A synthetic chromatogram computer program of others was used to analyze the error introduced by this isotope fractionation effect and led to: alternative means of calculating the true isotope ratio; methods for determining the error function of the ratio; and methods for distinguishing isotope effects from radiochemical impurities. While the error introduced by such isotope effects is usually small, from a practical standpoint, it must be recognized in order that proper and consistent correction can be applied to the values obtained in isotope dilution analyses. (P.C.H.)

7345 ANALYSIS OF OXYGEN-18 BASED ON THE REACTION $O^{18}(\alpha,n)Ne^{21}$. S. Amiel (Atomic Energy Commission, Yavne, Israel) and A. Nir. Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/25, 9p. (CONF-641001-3)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The nuclear reaction $^{18}O(\alpha,n)^{21}Ne$ was used for the analysis of various ^{18}O-labeled substances by bombarding the samples in an alpha particle flux from a radioactive source and counting the neutron emission produced. Different types of samples were studied in the solid, liquid, and gaseous phases. The output of neutrons from the reaction was found to be proportional to the ^{18}O concentration. The measurements were carried out both batchwise and by continuous scanning of a paper chromatogram, moving the sample through the alpha particle beam. The efficacy of the method stems from the substantial yield of neutrons obtained, namely 30 neutrons per 10^6 alpha particles from ^{210}Po (E_α = 5.3 Mev), or 150 and 420 neutrons, respectively, per 10^6 particles from ^{228}Th (E_α = 5.4 to 8.8 Mev) or an active deposit of thoron (E_α = 6.1 to 8.8 Mev). Background may be caused by several light elements; particularly, interference might arise from beryllium, boron, and to a lesser extent fluorine and lithium when present in proportions comparable to that of ^{18}O. Another source of background is natural oxygen. Detection efficiencies of 2 to 5% were obtained in various experimental set-ups using BF_3 proportional counters and scintillation detectors. In the case of paper chromatograms, sensitivities of a few micrograms of ^{18}O per cm^2 were obtained with fluxes of $\sim 10^7$ α/sec from an active deposit of thoron ($T_{\frac{1}{2}} \sim 11$ hours), using a scanner of a 4π geometry with four BF_3 detectors embedded in a paraffin block. The use of different alpha sources and detection systems, and the characteristics of the $(\alpha,n\gamma)$ reaction as an alternative method are discussed. Comparison was made with other detection methods of oxygen tracers. (P.C.H.)

7346 SUBSTOICHIOMETRIC RADIOMETRIC ANALYSIS: DETERMINATION OF TRACE AMOUNT OF COBALT. A. R. Landgrebe, L. McClendon, and J. R. DeVoe (National Bureau of Standards, Washington, D. C.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/59, 13p. (CONF-641001-15)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Substoichiometric radiometric analysis, which is a modification of the isotopic dilution method, is described. Two procedures (column and batch) of analysis were developed using substoichiometric amounts of EDTA. Excess cobalt ions were removed from solution with a cationic ion exchanger in the sodium form. Experiments were performed to determine the effect of contact time, pH, ionic strength, and buffers on the sensitivity of the method. Buffering solutions investigated were sodium acetate, ammonia-ammonium chloride, trisodium phosphate, and diethylamine. The method gave reproducible results with an acetate buffer for the concentration range of 10 to 0.1 μg/ml of cobalt. With diethylamine buffer preliminary results appear to be meaningful at the nanogram/ml level. The concentration range investigated using diethylamine buffer was from 5×10^{-3}M to 5×10^{-10}M cobalt using batch experiments in which one gram of Dowex 50-X8, 20-50 mesh was equilibrated with 10 ml of aqueous solution containing a substoichiometric amount of EDTA but an amount greater than the total cobalt concentration. Another application of this method includes the measurement of specific activities of radioisotopes. Measurement of ^{60}Co obtained from ORNL

has been done. It will be shown that substoichiometric isotopic dilution analysis is the limiting case of a more general phenomenon which is called, for want of a better name, substoichiometric radiometric analysis. (P.C.H.)

7347 NEUTRON-ACTIVATION ANALYSIS OF ELEMENTS AT CONCENTRATIONS OF LESS THAN 1 PART IN 10^9. Chester E. Gleit (Tracerlab, Richmond, Calif.), Walter D. Holland, Philip A. Benson, and Irving J. Russell. 25p. (CONF-446-65)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Five types of organic filter media and high purity quartz were analyzed for Ag, Cd, In, Tb, Ho, Er, Tm, Re, and Au. Organic matter was removed by reaction with electrically excited oxygen before neutron irradiation. After irradiation radiochemical separations stressing rigorous purification were utilized. A combination of beta counting and gamma spectroscopy was employed to determine the activity of the separated elements and to check sample purity. Concentrations as low as one part in 10^{11} were measured. A study of the sources of experimental error indicates that the technique is capable of yielding quantitative data and that the large observed variations in concentrations are due to nonuniformity among the specimens. (auth)

7348 A STUDY OF THE ESTIMATION OF SUBMICROGRAM AMOUNTS OF IODINE BY THE IODATE-IODIDE REACTION USING I^{131}. C. B. Oxby and J. B. Dawson (Univ. of Leeds, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/18, 11p. (CONF-641001-5)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The method of determining iodine by using the isotopic exchange between iodine and iodide in aqueous solution. Sodium iodide-^{131}I is added to the sample iodine to be estimated and both oxidized to iodate. A known amount of potassium iodide is added reducing the iodate to iodine. The isotopic exchange between iodine and iodide then occurs. After a few seconds the specific activity of the iodine is equal to that of the iodide, consequently solvent extraction of the iodine and measurement of its radioactivity, enables the amount of sample iodine to be calculated, since the specific activity of the iodide is known. This procedure gives an absolute method of extreme sensitivity for the determination of iodine. However, the accuracy of the method is limited by two factors. First, a scatter of results of $\pm 0.015\mu g$, the cause of which could not be determined but the experimental results indicated it arose during the bromine removal stage. Secondly, a blank value of $0.05\mu g$, arising from the degradation of the added stable iodide. These two effects, although significant when determining sub-microgram amounts of iodine, did not introduce any unacceptable error in the determination of $1\mu g$ of iodine and above. (P.C.H.)

7349 INSTRUMENTAL ACTIVATION ANALYSIS OF METEORITES INVOLVING BOTH THERMAL AND FAST NEUTRONS. D. E. Fisher and R. L. Currie (Cornell Univ., Ithaca, N. Y.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/45, 20p. (CONF-641001-36)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Data are presented to show how several elements, from the most abundant down to concentrations of 10^{-4} grams/gram, may be determined in meteorites by proper choice of irradiation times and of energy spectra of incident neutrons. The experimental method consists of irradiating the meteoritic specimens in a reactor, then removing them to a scintillation counter and abstracting characteristic gamma rays on a multi-channel analyzer. A typical specimen is first wrapped in cadmium, irradiated for ten seconds, and immediately counted to determine its fluorine content by means of the fast-neutron-induced reaction $^{19}F(n,\alpha)^{16}N$. After all activities have died down, it is reirradiated for two minutes for the determination of its oxygen content by the $^{16}O(n,2n)^{15}O$ reaction and its silicon content by the reaction $^{28}Si(n,p)^{28}Al$. Again after cooling, a long irradiation gives the magnesium content by the reaction $^{24}Mg(n,p)^{24}Na$. The cadmium cover is removed, and a one-minute irradiation yields the aluminum content by the reaction $^{27}Al(n,\gamma)^{28}Al$ induced by thermal neutrons. Other thermal neutron reactions, induced with the proper irradiation times, are $^{55}Mn(n,\gamma)^{56}Mn$, $^{63}Cu(n,\gamma)^{64}Cu$, $^{45}Sc(n,\gamma)^{46}Sc$, $^{59}Co(n,\gamma)^{60}Co$, $^{23}Na(n,\gamma)^{24}Na$, and $^{50}Cr(n,\gamma)^{51}Cr$. Results of these analyses are presented for several chondritic meterorites. The measured values range from about 30% for oxygen down to about 0.01% for fluorine and copper. (P.C.H.)

7350 THE CONTRIBUTION TO THE THEORY AND METHODS OF RADIOMETRIC TITRATIONS. J. Toelgyessy, V. Jesenák, and T. Braun (Slovak Technical Univ., Bratislava and Lorand Eötvös Univ., Budapest). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/107, 18p. (CONF-641001-33)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Mathematical analysis of the equivalent point determination by the extrapolation method is discussed. The dependence of a relative error in equivalent point extrapolation determination on other constants of radiometric precipitation titration is described. Theoretical values were compared with experimental data and good agreement was found. An arrangement of the dependence equation into dimensionless relation and an experimental result evaluation method without linear extrapolation errors are proposed. An example from practice indicates the advantages of this method for operational analysis. The complete evaluation of dimensionless equations using electronic computer ZRA I was made. This calculated the precipitation and dissolution curves and linear extrapolation errors for a wide range of variables. This enables the objective investigation of the effect of individual parameters both in precipitation analytical reactions as in precipitations with higher solubility product which are usual in engineering practice. Further a method of radiometric titrations evaluation of great importance in running analysis is proposed. New methods, such as radiocoulometric titrations, beta-backscattering radiometric titration, and beta-absorption radiometric titration, are described. (P.C.H.)

7351 THE DETERMINATION OF DEUTERIUM IN THE SURFACE LAYERS OF D_2O-OXIDIZED ZIRCALOY-2 BY THE $D(d,n)^3He$ REACTION. J. P. Butler (Atomic Energy of Canada Ltd., Chalk River, Ont.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/99, 21p. (CONF-641001-8)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A method employing the $D(d,n)^3He$ reaction was developed for the rapid analysis of deuterium in the surface layers (thickness 15 μm or less) of Zircaloy-2 corroded in heavy water steam. Samples were irradiated with a monoenergetic beam of deuterons from an ion accelerator and the amount of deuterium in the sample was determined from the neutron production and the integrated beam current. A neutron long counter placed at 0° to the beam was used to measure the neutron production. The absolute amount of deuterium was obtained by comparing the neutron production from the sample with the neutron production from a known amount of deuterium in a deuterium gas target cell containing sufficient deuterium to stop the beam in the gas. The concentration of deuterium as a function of depth in the sample was investigated by varying the deuteron bombarding energy and hence the range of the deuterons in the sample. For deuterons in the energy range 0.2 to 1.8 Mev and beam currents of 0.5 to 3 μA a sensitivity of better than 5 ppm was obtained. The method has the added advantage that it is non-destructive and can be performed quickly, requiring only a few minutes' irradiation at each bombarding energy. The surface layers of pellets of deuterated p-terphenyl also were analyzed for deuterium at various deuteron bombarding energies and the results were in good agreement with the theoretical value. Interfering reactions and methods of decreasing the background neutron counting rate are also discussed. (auth)

Inorganic and Physical Chemistry

Refer also to abstract 8464.

7352 (BMI-1706) VAPOR DEPOSITION OF FILMS OF NEODYMIUM COMPOUNDS. Thomas Gabor, John M. Blocher, Jr., and Robert C. Bowman (Battelle Memorial Inst., Columbus, Ohio). Dec. 1, 1964. Contract W-7405-eng-92. 20p. Dep.; $0.50(OTS).

The formation of dense, adherent films of neodymium compounds was explored as a model for the deposition of promethium-compound films for subsequent use in a ^{147}Pm atomic battery. Adherent, dense, and transparent films of NdF_3 were deposited on silicon and aluminum by condensation of NdF_3 vapor. The possibility of chemical vapor transport was also investigated. However, no conditions were found for the transport of oxide within the temperature limitations of the substrate. During this work, a method was developed to increase adhesion of Nd_2O_3 films to silicon by the use of butadiene-styrene copolymer latex binder, and also by the use of a highly cross-linked carbon. (auth)

7353 (EURAEC-1225(Pt.2)) A STUDY OF SOME METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Quarterly Report No. 10, July 1–September 30, 1964. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10 TEEB. 24p. Dep.(mn); $2.00(cy), 1(mn) OTS.

An electrolysis cell was developed for the study of redox behavior and of surface effects on electrochemical reaction kinetics. The study of the stability of platinum surfaces is discussed. Results of a comparison of the capacitive and coulometric behavior of platinum electrodes are surveyed. (D.L.C.)

7354 (HW-38311(Rev.)) THERMODYNAMICS OF IODINE REMOVAL WITH THE SILVER REACTOR. L. L. Burger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1, 1955. Contract AT (45-1)-1350. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A summary is presented of some of the thermodynamic calculations made for the reactions occurring in the fixation of iodine in dissolver off-gases by hot silver nitrate. Free energies of reaction are tabulated at 298, 400, and 500°K. ICl is the predominant iodine species in the gas entering the reactor, and both AgI and $AgIO_3$ may be formed in the $AgNO_3$–I reaction. Reactions with ammonia are considered. (D.L.C.)

7355 (IS-992) VOLUME-TEMPERATURE RELATIONSHIPS OF SOME RARE-EARTH CHLORIDE SOLUTIONS. Wayne Merlyn Gildseth and F. H. Spedding (Ames Lab., Ames, Iowa). Aug. 1964. Contract W-7405-eng-82. 186p. Dep.; $5.00(cy), 3(mn) OTS.

A dilatometric apparatus was constructed which was capable of measuring the change in density of a liquid or solution with an accuracy of about two parts per million over the temperature range of 20 to 80°C. The variations of the volumes of the dilatometers with temperature were determined using mercury as a standard. Densities of water and aqueous lanthanum chloride and neodymium chloride solutions were determined at five-degree temperature intervals from 20 to 80°C. Twelve lanthanum chloride solutions ranging in concentration from 0.06362 to 3.3907 molal and eleven neodymium chloride solutions ranging in concentration from 0.1050 to 3.4160 molal were investigated. These data were used to calculate coefficients of thermal expansion of water and the rare-earth chloride solutions. Apparent and partial molal volumes of the salt, apparent and partial molal expansibilities of the salt, and partial molal volumes and expansibilities of water in these rare-earth chloride solutions were also calculated. Empirical least square equations were computed with the use of an IBM 7074 computer to represent the above properties versus temperature and versus concentration. From a study of the values of the above properties, it was concluded that the water molecules in the neighborhood of a neodymium ion were more tightly bound than those about a lanthanum ion. In addition, the results obtained were in agreement with the formation of a pseudo salt-like lattice of the ions in the most concentrated solutions. (auth)

7356 (IS-1023) THE CARBON REDUCTION OF URANIUM OXIDE. H. A. Wilhelm (Ames Lab., Ames, Iowa). Oct. 1964. Contract W-7405-eng-82. 38p. Dep.; $2.00 (OTS).

Previous work on the carbon reduction of uranium oxide to the metal is reviewed. Some experimental work on the reaction between UO_2 and carbon is described. It is concluded that to obtain high yields of good uranium metal by direct carbon reduction will require new developments in container materials and/or processing techniques. Some refractory materials for possible use as crucibles are discussed. (D.L.C.)

7357 (IS-1052) LCR-2—A FORTRAN LATTICE CONSTANT REFINEMENT PROGRAM. Donald E. Williams (Ames Lab., Ames, Iowa). Nov. 1964. Contract W-7405-eng-82. 17p. Dep.; $1.00(OTS).

A computer program is described which refines lattice constants for any crystal symmetry by the least squares method. Several types of extrapolation functions are provided, and these functions can be used either singly or in combination. A complete error treatment is made, including covariances between parameters. (auth)

7358 (MATT-235) MAGNETIC EFFECTS IN CERTAIN SYSTEMS OF CHEMICAL ENGINEERING INTEREST. F. W. Camp and E. F. Johnson (Princeton Univ., N. J. Plasma Physics Lab.). Sept. 1963. Contract AT(30-1)-1238. 46p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Magnetic Effects on Thermodynamic Equilibria. The application of uniform magnetic fields may cause shifts in physical and chemical equilibria. A method of analysis is presented by which it is possible to evaluate these shifts. The method is illustrated by a calculation of magnetically induced changes in the boiling points of water and of oxygen. These changes are found to be small for most engineering applications. Magnetic Effects on Rate Processes. The equilibrium theory of reaction rates may be used to estimate possible magnetic effects on chemical reaction. Magnetohydrodynamic effects are well-known and have been treated in detail by several authors. Magnetic effects have been observed in other physical rate processes, but the physical theories of these processes are generally inadequate at present to describe and predict the magnetic effects. The magnetic effects observed on physical processes (excluding magnetohydrodynamic effects) and the effects predicted on chemical reaction ratio are very small. Effects of a Magnetic Field Gradient on Physical Rate Processes. It is well known that gradients of processing conditions (e.g. temperature, pressure) may cause cross phenomena such as thermal diffusion. These phenomena may be investigated using the thermodynamics of irreversible processes. In particular, the possibility of a diffusion flux caused by a magnetic field gradient is examined in some detail. While the effects predicted are small, these effects operating over large periods of time can conceivably have large consequences. (D.L.C.)

7359 (ML-TDR-64-124) INFRARED SPECTRA OF TRANSITION METAL ALKOXIDES. C. T. Lynch, K. S. Mazdiyasni, J. S. Smith, and W. J. Crawford (Wright Air Development Div. Materials Lab., Wright-Patterson. AFB, Ohio). Mar. 1964. 42p. (AD-604688). $2.00(OTS).

The infrared spectra of a number of transition metal isopropoxides and tetra tertiary butoxides were obtained from 5000 to 285 cm^{-1}. The spectra were compared to existing infrared data on these classes of compounds. Characteristic absorptions for the isopropoxy group have been found at 1160 to 1175 cm^{-1} and at 1120 to 1140 cm^{-1}. They are assigned to isobranching vibrations. The isopropoxides exhibit a doublet at about 1375 cm^{-1} and 1365 cm^{-1} characteristic of the gem-dimethyl structure. The

major feature of the spectra is a very strong band in 1000 cm^{-1} region assigned as the C–O stretch vibration, which is shifted by the influence of the specific metal atom on the C–O vibration. The butoxides have four characteristic absorptions at about 785, 900, 1010, and 1190 cm^{-1}. The band in the 1000 cm^{-1} region appears to be the C stretch vibration; the other bands are attributed to skeletal vibrations of the tert-butyl group. The typical C–H deformation of the tert-butyl group is observed at about 1360 cm^{-1} with a weaker band at 1380 cm^{-1}. In the medium infrared region to 285 cm^{-1}, a small number of very strong absorption bands are found for the tert-butoxides. The results suggest that the region would be very satisfactory for characterizing tert-butyl compounds. (auth)

7360 (MLM-1212) POTASSIUM PLUTONIUM SULFATE. D. R. Rogers and W. B. Brown (Mound Lab., Miamisburg, Ohio). July 31, 1964. Contract AT(33-1)-Gen-53. 13p. Dep.; $1.00(cy), 1(mn) OTS.

Potassium plutonium-238 sulfate ($K_4Pu(SO_4)_4 \cdot 2H_2O$) is prepared by reacting plutonium-238 sulfate in 2M H_2SO_4 with a saturated solution of K_2SO_4. The solution is heated to boiling and allowed to stand for 12 hours. The resulting green crystals are filtered off, washed with 50% ethanol and air dried for 24 hours. This double sulfate compound is being investigated for use as a primary standard for plutonium-238. A solubility study was performed to establish the optimum conditions for preparation. The solubility product constant was determined to be 10^{-18}. The compound was stable for at least three months when stored in a tightly capped stainless steel bottle which served as a heat sink. Potassium plutonium sulfate, which dissolves easily in 2M HNO_3, has been used to prepare radioactive standards for 2π, 4π, and low geometry counting techniques. (auth)

7361 (AERE-Trans-1011) METAL NITRIDES. I. BARIUM PERNITRIDE. S. M. Ariya and E. A. Prokof'eva. Translated by J. M. Crabtree (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Sb. Statei Obshch. Khim., Akad. Nauk SSSR, 1: 9-18(1953). 17p. Dep.; $0.60(BIS); 3s. (HMSO).

Enthalpies of formation have been deduced for SrN_6 ($\Delta H^0 = 0.1$ kcal/mole) and for LiN_3 ($\Delta H^0 = 3.1$ kcal/mole) from determinations of heats of neutralization of solutions of hydrated strontium and lithium oxides with hydrazoic acid and heats of solution of strontium and lithium azides. Accordingly the value quoted in the reference books for the enthalpy of formation of strontium azide (49 kcal) is in error. It has been established that decomposition of strontium amide under high vacuum leads to formation of strontium nitride and metallic strontium (perhaps forming solid solutions). Therefore Hartmann's assertion that strontium pernitride Sr_3N_4 is formed under these conditions is in error. Study of the reaction between lithium nitride and nitrogen at high pressures did not confirm Dutoit's data regarding formation of a compound Li_2N. At 400–500° and a pressure of 200–300 atm, nitrogen reacts with barium nitride to form barium pernitride BaN_2. Decomposition of barium azide under these conditions also results in formation of BaN_2. On the basis of measurements of the magnetic susceptibility of barium pernitride it is suggested that this compound has a lattice containing N_2^{3-} ions with no unpaired electrons. Results of a study of the interaction of lithium and barium nitrides with nitrogen are in agreement with estimates of the energies of formation of higher nitrides of these elements using Shchukarev's method. (auth)

7362 (UCRL-Trans-1153(L)) THE REDUCTION POTENTIALS OF THE TRIVALENT EARTHS. W. Noddack and A. Bruki. Translated by D. McCallum (Univ. of California, Livermore), from Angew. Chem., 50: 362-5(1937). 29p. Dep.(mn); $2.60(fs), $1.07(mf) JCL.

Three rare earths (Sm, Eu, and Yb) can form divalent compounds and thus can be separated from the other rare earths. An investigation was conducted to determine whether the other rare earths can exhibit the same divalent character. 0.01M solutions of pure rare earth sulfates were electrolyzed using a dropping mercury electrode and the current-voltage curves plotted. All the resulting curves had two steps (corresponding to reduction to the divalent and metallic states, respectively); the difference between the steps was greatest for Sm, Eu, and Yb. The possible existence of stable divalent Sc and Gd is suggested. The basicity trends of the rare earths are discussed briefly. (D.L.C.)

7363 REFRACTOMETRIC STUDY OF THE SYSTEM $La(NO_3)_3$–Me^INO_3 IN AQUEOUS SOLUTION. P. Spacu. Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 373-84(1963). (In Rumanian)

Results of a study of systems of the type $La(NO_3)_3$–Me^INO_3, in which Me^I = Na, K in equimolecular and non-equimolecular solutions, determined by refractometry are presented. Results indicate the forming of the following compounds in aqueous, concentrated solutions: $[La(NO_3)_5]Na_2$, $[La(NO_3)_4]Na$, $2La(NO_3)_3 \cdot 3NaNO_3$, $[La(NO_3)_5]K_2$, $2La(NO_3)_3 \cdot 3KNO_3$. For the compound $[La(NO_3)_5]K_2$ identified in the solution, corresponding to the molecular ratio $La(NO_3)_3 : 2KNO_3$, molecular refraction was determined and compared with that of the solid compound. (Roumanian Sci. Abstr., Nat. Sci. 1: No. 1-2(Jan.-Feb. 1964))

7364 AN X-RAY AND NEUTRON DIFFRACTION STUDY OF METACINNABARITE. Karin Aurivillius (Univ. of Stockholm). Acta Chem. Scand., 18: 1552-3(1964).

The crystal structure reported previously for HgS (metacinnabarite) was confirmed by x-ray single-crystal and neutron powder diffraction data. The cell edge of a synthetic sample was found to be 5.8717 ± 0.0005Å. The interatomic distance Hg–S is consequently 2.5424 ± 0.0002Å. (M.C.G.)

7365 KINETICS OF THE REACTION H + D_2 = HD + D. W. R. Schulz and D. J. LeRoy (Univ. of Toronto). Can. J. Chem., 42: 2480-7(Nov. 1964).

The rate constant for the reaction H + D_2 = HD + D was measured in the temperature range from 368 to 468°K. It was found to be given by the relation: $k_4 = 4.3_7 \times 10^{12}$ exp $(-7.3_9 \times 10^3/RT)$ cm^3 $mole^{-1}s^{-1}$. A comparison was made with previous experimental and theoretical work on the reaction. (auth)

7366 THE THERMAL DISSOCIATION OF SOME METAL CUPFERRATE CHELATES. W. W. Wendlandt, S. Iftikhar Ali, and C. H. Stembridge (Texas Technological Coll., Lubbock). Anal. Chim. Acta, 31: 501-8(Dec. 1964).

The thermal dissociation of the cupferron complexes with Cu(II), Ni, Co(II), Zn, Cd, Mn(II), Hg(II), Mg, Ca, Ba, Sr, Al, Fe(III), Ce(III), La, and Nd was studied by differential thermal analysis (DTA) and by pyrolysis into a mass spectrometer. The DTA curves consisted mainly of endothermic peaks although some contained exothermic peaks as well. The mass spectrometer showed that cupferron decomposes slightly above room temperature, giving off N_2, NO, N_2O, NH_3, and H_2O. A mechanism for the thermal dissociation of the copper(II) cupferrate is proposed. (auth)

7367 A POTENTIOMETRIC STUDY OF THE PICOLINATES OF LANTHANUM, PRASEODYMIUM AND NEODYMIUM. Laurent Moyne and Germaine Thomas (Laboratoire de Chimie Minerale et Analytique, Faculté des Sciences, Lyon). Anal. Chim. Acta, 31: 583-9(Dec. 1964). (In French)

A potentiometric method was used to determine the stepwise stability constants of lanthanum, praseodymium, and neodymium picolinates in aqueous solution at two ionic strengths (μ = 0.02 and μ = 0.5; sodium perchlorate medium) at 25°. The stability and the solubility of these picolinates increased from La to Nd. (auth)

7368 MECHANISMS OF INTERACTIONS OF ALKALI AND ALKALINE EARTH ELEMENTS IN FLAME PHOTOMETRY. Russell W. Johnson and W. G. Schrenk (Kansas State Univ., Manhattan). Appl. Spectry., 18: 144-8(1964).

Cationic interactions in flame photometry were investigated to study some of the factors that cause enhancements of spectral lines. Interactions of the alkali and alkaline earth metals in an oxygen-acetylene flame indicated that several mechanisms may be responsible for the enhance-

ment. Where conditions are proper, enhancements of emissions of cations may be a combination of at least three factors: the effect of electron concentration from an easily ionized extraneous element on the ground state population of the test element; the effects of transfer of energy by radiation; and the effects of transfer of energy due to collisions with excited atoms. The effects of the electron concentration on the suppression of the ionization of the test element was the predominant mechanism by which enhancement occurred in most systems studied. However, in the study of the effect of potassium on rubidium direct evidence was obtained for excitation by transfer of radiant energy. Indirect evidence of enhancement due to transfer of energy by collision also was observed in the same system. (auth)

7369 TRANSFORMATION OF RUTHENIUM DIOXIDE IN THE PRESENCE OF CHROMIC OXIDE. M. K. Baranaer, V. G. Vereskunov and K. P. Zakharova. At. Energ. (USSR), 17: 502(Dec. 1964). (In Russian)

Thermal transformation in hydrated ruthenium oxide mixtures with chromium hydroxide was investigated. The results showed that an esothermic effect, similar to that taking place during RuO_2 transformation from an amorphous to a crystalline state, also takes place during hydrated ruthenium oxide thermal treatment at 410°C. Catalytic effects of chromic oxide on RuO_2 oxidation to RuO_4 at 300 to 700°C are discussed. (R.V.J.)

7370 RARE EARTH OXIDES. Frank H. Spedding and Karl A. Gschneidner, Jr. (Ames Lab., Ames, Iowa). Ind. Res., 6: 60-5(Dec. 1964).

The properties, structure, and applications of rare earth oxides are reviewed. The stability of rare earth oxides is also discussed. (P.C.H.)

7371 ALUMINOTHERMAL REDUCTION OF YTTERBIUM OXIDE. G. G. Gvelesiani and A. A. Nadiradze. Izv. Akad. Nauk SSR, Met. i Gorn. Delo, No. 5, 57-65(Sept.-Oct. 1964). (In Russian)

The equilibrium vapor pressure of Yb in the aluminothermal reduction of Yb_2O_3 was determined from the equation $P = 8.953 - 12666.7\ (1254 - 1473°K)/T$. In this reduction of Yb_2O_3 and oxidation of liquid Yb the change in isobaric potential with temperature is given by $\Delta Z^0_T = 115{,}900 - 55.57T$ (1254–1473°K) and $\Delta Z^0_T = -436{,}536 + 3.43T \ln T + 62.63T$ (1254–1473°K). Optimum conditions are on Al/Yb_2O_3 mole ratio of 3, 2 hr at 1200°C, pelletting pressure of 5000 to 7500 kg/cm, milled size of Al and Yb_2O_3 from −0.25 + 0.1 to −1 + 0.5 mm, system vacuum at 0.01 to 0.001 mm Hg. In the reduction two intermediate products are formed: the alloy Al_xYb_y and $YbAlO_3$. Initially the rate is determined by the rate of transfer of Yb from the alloy to the vapor and then, with accumulation of a thick layer of solid slag, the reaction goes into the diffusion region. The Yb obtained under optimum conditions contains up to 0.11% Al and traces of Ca. (tr-auth)

7372 STRUCTURAL-KINETIC INVESTIGATION OF METALLIC SCANDIUM OXIDATION. O. P. Naumkin and D. V. Ignatov. Izv. Akad. Nauk SSSR, Met. i Gorn. Delo, No. 5, 142-6(Sept.-Oct. 1964). (In Russian)

Electron and x-ray structure studies and kinetic studies were made on air oxidation of Sc. Weight changes in a Sc sample heated 24 hr at 300°C were negligible, but an electron radiograph showed the presence of an oxide layer on the surface calculated to indicate a change of 22×10^{-4}. The weight change increased more rapidly at higher temperatures, e.g. to 5 mg/cm² in 24 hr at 900°C. The increase with time at 800 and 900°C was linear after a short parabolic part. Changes in microhardness along the width indicated that the oxidation takes place with diffusion of O_2 and N_2 through the oxide layer. Curves relating the weight changes in air at 400°C and the melting point of the rare earth metals to their atomic number are presented. (IIC–M.G.)

7373 HYDROGEN ISOTOPE EXCHANGE OF TRICARBONYL-BENZENE-CHROMIUM. V. N. Setkina, N. K. Baranetskaya, K. N. Anisimov, and D. N. Kursanov (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 1873-4 (Oct. 1964). (In Russian)

Tricarbonyl-benzene-chromium, $C_6H_6Cr(CO)_3$, was found to enter into a hydrogen isotope exchange reaction with deuterium-labeled alcohols and amines. At 100°C, in 10% sodium ethylate solution the velocity constant of the exchange reaction was 1.0×10^{-5} sec^{-1}. Benzene did not react similarly under these conditions. (IIC–M.G.)

7374 STUDIES OF ELECTRODE FUNCTION OF THE OXIDE-CARBON ELECTRODE, $Nd_2O_3-C-CO_2$, IN CHLORIDE MELTS CONTAINING TRIVALENT NEODYMIUM CHLORIDE. F. A. Kuznetsov, N. F. Didora, T. P. Chusova, and S. M. Artamonova (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 10-14(1964). (In Russian)

The EMF's of concentration cells with oxide-carbon, $Nd_2O_3-C-CO_2$, electrodes in melts containing $NdCl_3$ were measured. A deviation of the coefficient of the logarithmic term in the equation for the EMF concentration dependence is explained by the simultaneous occurrence of two electrode processes. It is suggested that oxychloride-carbon electrodes may prove convenient for studying rare earth chloride melts. (tr-auth)

7375 NITRATES OF THE CERIUM GROUP OF RARE EARTH METALS. K. E. Mironov, A. P. Popov, E. D. Ruchkin, and S. S. Batsanov (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 48-57(1964). (In Russian)

Crystalline nitrate hexahydrates of the cerium rare earths were prepared from nitric acid solutions and their compositions confirmed by Fisher determinations of the water. Photomicrographs of the crystals of the La, Ce, Pr, Nd, and Sm preparations are shown. Curves of weight loss vs time of dehydration over P_2O_5 showed the appearance of a tetrahydrate after about 75 hr but gave no indication of pentahydrates. Based on refraction and density measurements, the compounds are grouped: hexahydrates, La–Ce and Pr–Nd–Sm; tetrahydrates, La–Ce–Pr and Nd–Sm. Infrared spectra of the 10 preparations are shown. (IIC-M.G.)

7376 INVESTIGATION OF THE $UO_3-H_2O_2-H_2O$ SYSTEM. S. A. Durasova and A. V. Nikolaev (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 58-61(1964). (In Russian)

Isothermal solubility studies of the $UO_3-H_2O_2-H_2O$ system at 0 and 25°C indicated the previously unknown compounds $UO_4 \cdot H_2O_2 \cdot 3H_2O$ and $UO_4 \cdot 1.5H_2O_2 \cdot 4H_2O$. The properties determined for the first compound confirmed its peroxide nature. (tr-auth)

7377 OPTICAL INVESTIGATION OF HYDRATED URANIUM PEROXIDE. E. D. Ruchkin and S. A. Durasov (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 62-6(2964). (In Russian)

Refraction and density measurements on $UO_4 \cdot 4H_2O$ and $UO_2 \cdot 2H_2O$ and calculated molar refractivities, together with the molar refraction of water of crystallization, showed a difference between the structure of the two compounds (3.74 cm³). Infrared absorption spectra of the compounds and their deuterated analogs gave information on the crystallo-hydrate nature of these compounds and on the presence of hydrogen bonding in both $UO_4 \cdot 4H_2O$ and $UO_4 \cdot 2H_2O$. (tr-auth)

7378 PHYSICO-CHEMICAL INVESTIGATION OF THE $HF-CeO_2-H_2O$ SYSTEM. A. A. Opalovskii (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 67-73 (1964). (In Russian)

In the $HF-CeO_2-H_2O$ system, CeO_2 solubility increased with increasing HF concentration to a maximum solubility of 1.64% in 11.25% HF. The solids formed in the reaction of CeO_2 with dilute HF were of indeterminate composition. With increasing HF concentration, the amount of CeF_4 in the solid phases increased and the CeO_2 content decreased. At 16% HF all the CeO_2 was converted to CeF_4. With 16 to 64% HF, the solid phase composition was $CeF_4 \cdot 0.06\ H_2O$. With 64 to 100% HF, anhydrous CeF_3 formed. (IIC-M.G.)

7379 ON THE COMPOSITION OF ZIRCONIUM SALICYLATE. P. I. Artyukhin (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sibirsk. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 2, 141-3(1964). (In Russian)

In the precipitation of zirconium salicylate, with increasing solution acidity and increasing salicylic acid concentration, the composition of the precipitate continuously changed from the pure hydroxide to Sal/Zr = 2/1. (tr-auth)

7380 THE THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE AQUEOUS SOLUTIONS. IV. ENTROPIES OF THE IONS UP TO 200° AND THE CORRESPONDENCE PRINCIPLE. Cecil M. Criss and J. W. Cobble (Purdue Univ., Lafayette, Ind.). J. Am. Chem. Soc., 86: 5385-90 (Dec. 20, 1964).

A general treatment was developed, which describes the entropies of ions in solution in terms of various ionic and solvent parameters. By using the entropies themselves at some reference temperature to define these parameters, it was possible to derive a principle of entropy correspondence for ions between different temperatures. If the standard state was chosen properly by fixing the entropy of $H^+(aq)$ at each temperature, then the ionic entropies at one temperature were linearly related to their corresponding entropies at 25°C. A generalized treatment of nonaqueous solvents also followed directly from the theory. Various equilibria and thermochemical data from the literature were used to calculate the partial molal entropies for over forty solutes, and a consistent set of ionic entropies is given for higher temperatures. These experimental entropies are in good agreement with the correspondence principle, and preliminary constants are given to allow the prediction of entropies up to 200°C for the common types of ions. (auth)

7381 THE THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE AQUEOUS SOLUTIONS. V. THE CALCULATION OF IONIC HEAT CAPACITIES UP TO 200°. ENTROPIES AND HEAT CAPACITIES ABOVE 200°. Cecil M. Criss and J. W. Cobble (Purdue Univ., Layfayette, Ind.). J. Am. Chem. Soc., 86: 5390-3(Dec. 20, 1964).

Equations are given for calculating heat capacities at 25°C and at elevated temperatures from the correspondence principle for entropies previously developed. (auth)

7382 THE THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE AQUEOUS SOLUTIONS. VI. APPLICATIONS OF ENTROPY CORRESPONDENCE TO THERMODYNAMICS AND KINETICS. J. W. Cobble (Purdue Univ., Lafayette, Ind.). J. Am. Chem. Soc., 86: 5394-5401 (Dec. 20, 1964).

In previous work the general nature of the principle of entropy correspondence was demonstrated. This, in turn, led to reliable predictions of the partial molal heat capacities of ionic species over wide temperature ranges. The usefulness of the correspondence principle was extended by illustrating its application in a wide variety of situations of interest to the chemical sciences. Selected high temperature solubilities, dissociation constants, and cell potential data were predicted or evaluated on a more sound thermodynamic basis. The kinetic consequences of entropy correspondence were examined; this resulted in the prediction of a class of reactions that follow "retrograde kinetics." (auth)

7383 THE THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE AQUEOUS SOLUTIONS. VIII. STANDARD PARTIAL MOLAL HEAT CAPACITIES OF GADOLINIUM CHLORIDE FROM 0 TO 100°. Eugene C. Jekel, Cecil M. Criss, and J. W. Cobble (Purdue Univ., Lafayette, Ind.). J. Am. Chem. Soc., 86: 5404-7(Dec. 20, 1964).

The integral heat method was used to determine the partial molal thermal capacities at infinite dilution of aqueous gadolinium chloride from 0 to 100°C. From the extrapolated values of the heats of solution at infinite dilution, values of $\overline{C}_{P_2}^{\circ}$ as a function of temperature were calculated. For a representative 3–1 electrolyte, the observed thermal capacities were negative and the heat capacity-temperature behavior was similar to that of other simple electrolytes. Since gadolinium chloride possesses such a high exothermic heat of solution, a more sensitive and accurate type of submarine calorimeter of short thermal lag was constructed. This calorimeter, which utilizes a thermistor sensing device, is described. (auth)

7384 A STUDY ON THE STABILITY OF XENON TRIOXIDE IN BASIC SOLUTIONS. Charles W. Koch and Stanley M. Williamson (Univ. of California, Berkeley). J. Am. Chem. Soc., 86: 5439-44(Dec. 20, 1964).

The reaction of $XeO_3(aq)$ with NaOH and KOH solutions in the range of 0.25 to 4.2M and 2.0 to 3.6M, respectively, at room temperature gave a 33% yield of the alkali perxenate. Higher $[OH^-]$ and temperature increase the yield. Lowering the $[OH^-]$ toward the neutral point led to the direct decomposition of XeO_3. For comparable concentrations for LiOH, the yield of perxenate was 50% and higher. A yellow, mixed oxidation state complex with variable stoichiometry formed predominantly in the NaOH and KOH systems. It provided a mechanism by which Xe(VI) directly decomposed to $Xe + 1.5O_2$. In the KOH system, the complex was present as a solid during most of the course of the reaction. Subsequently, $K_4XeO_6 \cdot 9H_2O$ was isolated. The relative stabilities of the alkali and alkaline earth perxenates, a mechanism for the disproportionation–decomposition reaction of XeO_3, and the nature of the mixed oxidation state complex are presented. (auth)

7385 FLUORESCENCE AND STIMULATED EMISSION FROM $La_2O_3:Nd^{+3}$. R. H. Hoskins and B. H. Soffer (Korad Corp., Santa Monica, Calif.). J. Appl. Phys., 36: 323-4 (Jan. 1965).

The rare-earth sesquioxides may exist in three forms. These polymorphs have hexagonal, monoclinic, and cubic structure and are generally called type A, B, and C, respectively. Stimulated emission was previously reported from $Gd_2O_3:Nd^{3+}$ (type B) and $Y_2O_3:Nd^{3+}$ (type C). The observation of stimulated emission from $La_2O_3:Nd^{3+}$, an example of the type-A structure is reported. (C.E.S.)

7386 KNIGHT SHIFTS AND RELAXATION TIMES OF ALKALI-METAL AND NITROGEN NUCLEI IN METAL–AMMONIA SOLUTIONS. D. E. O'Reilly (Argonne National Lab., Ill.). J. Chem. Phys., 41: 3729-35(Dec. 15, 1964).

Knight shifts of ^7Li, ^{23}Na, ^{87}Rb, ^{133}Cs, and ^{14}N in alkali-metal-ammonia solutions were measured at 300°K and in the concentration range 0.03 to 1 mole liter^{-1}. ^{23}Na NMR was observed at Na concentrations down to 0.003 mole liter^{-1} at 300°K and in the range 0.03 to 4 mole liter^{-1} at 274 and 240°K. ^{14}N shifts are reported for concentrations from 0.008 to 4 mole liter^{-1} at 300 and 240°K. Linewidths of ^{87}Rb and ^{133}Cs were obtained at 300°K in the concentration range 0.03 to 0.8 mole liter^{-1}. At 0.35 mole liter^{-1} and 300°K the shifts of Li, Na, Rb, and Cs are 9, 72, 450, and 900 ppm, respectively, to lower magnetic field. Shifts of ^{14}N are nearly independent of metal at 300°K. The concentration and temperature dependence of ^{23}Na Knight shift data at concentrations up to 0.4 mole liter^{-1} may be quantitatively interpreted by the following reactions: $M \rightleftharpoons M^+ + e^-$, and $M + e^- \rightleftharpoons M^-$, where M represents the monomer species and the second one is the spin-pairing reaction. The ^{14}N spin density at unpaired electron is essentially independent of alkali metal and concentration up to 0.6 mole liter^{-1} and equal to $0.88 \pm 0.11\ \alpha_0^{-3}$ at 300°K. The electron spin density at ^{23}Na is calculated to be $\geq 8 \times 10^{-3}\ \alpha_0^{-3}$ approximately independent of temperature and concentration. The lifetimes of the Rb and Cs monomers at 300°K and 0.06 mole liter^{-1} are ≤ 3 and ≤ 4 $\mu\mu$sec, respectively, as determined from NMR linewidth measurements. The monomer lifetime decreases sharply with increase in metal concentration. (auth)

7387 TWO-STEP ENERGY TRANSFER IN SOLUTION. P. K. Gallagher, A. Heller, and E. Wasserman (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 41: 3921-4(Dec. 15, 1964).

In the presence of terbium ions, a transfer of energy was observed from 4,4'-dimethoxybenzophenone (DMB) to europium ions. This transfer did not take place in the absence of terbium and it was concluded that the terbium ion serves as an intermediate in the energy transfer. Fluorescence and excitation spectra, fluorescence lifetimes, and time-

resolved excitation spectra are presented to substantiate the proposed nonradiative two-step energy transfer. (auth)

7388 ISOTOPIC DETERMINATION OF THE VIBRATIONAL NUMBERING FOR THE $B^3\Pi_{0+u}$ STATE OF IODINE. Robert L. Brown and Thomas C. James (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 33-5(Jan. 1, 1965).

A measurement of the vibrational isotope displacements between $^{127}I_2$ and $^{129}I_2$ confirmed the revised vibrational numbering of the $B^3\Pi_{0+u}$ state proposed by Steinfeld et al. They observed that the traditional numbering must be decreased by one unit to bring their calculated fluorescence intensity distributions into agreement with experiment. (auth)

7389 ON THE MOTION OF HYDROGEN IN THE TANTALUM–HYDROGEN SYSTEM. Bjoern Pedersen (Central Inst. for Industrial Research, Oslo), Tore Krogdahl, and Odd E. Stokkeland. J. Chem. Phys., 42: 72-9 (Jan. 1, 1965).

The proton spin–lattice relaxation time T_1 was measured by a pulse technique as a function of temperature in a series of tantalum–hydrogen samples with hydrogen content from H/Ta = 0.1 to 0.66. The spin–lattice relaxation is determined by the rapid translational diffusion of the hydrogen atoms in the tantalum lattice. Discontinuities in the T_1 curves indicate two phase transitions in the temperature range investigated, 200 to 400°K. The transition temperatures depend on the composition of the sample in a way that is in conflict with the present view of the phase relations in the Ta/H system. The activation energy in the low-temperature phase (β_1 phase) was found to decrease linearly with increasing hydrogen content from 3.7 ± 0.5 kcal/mole in $TaH_{0.10}$ to 2.6 ± 0.3 kcal/mole in $TaH_{0.66}$. In the high-temperature phase (α phase) the activation energy is 1.6 ± 0.4 kcal/mole, and in the intermediate-temperature phase (β_2 phase) the activation energy is 6.3 ± 0.6 kcal/mole. Neither of the latter values changes significantly with the composition of the sample. (auth)

7390 EFFECT OF SOLVENTS ON ^{19}F SPIN-SPIN COUPLING CONSTANTS. Soon Ng, Jane Tang, and C. H. Sederholm (Univ. of California, Berkeley). J. Chem. Phys., 42: 79-84(Jan. 1, 1965). (UCRL-11540)

The effects of solvents on the coupling constants of the compounds $CF_2 = CFBr$, CF_3CFCl_2, and $CF_2BrCFBrCl$ were studied. The coupling constants were found to vary with the solvents. This implies that intermolecular interactions affect coupling constants to a degree that is not negligible. The variations in the coupling constants are to some extent correlated with the size, electronic character, and dipolar nature of the solvent molecules. The temperature dependence of fluorine coupling constants that has been reported previously may be due to this temperature-dependent molecular interaction as well as the population of excited vibrational states. (auth)

7391 OBSERVATION OF THE PRODUCTS OF IONIC COLLISION PROCESSES AND ION DECOMPOSITION IN A LINEAR, PULSED TIME-OF-FLIGHT MASS SPECTROMETER. R. E. Ferguson, K. E. McCulloh, and H. M. Rosenstock (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 100-6(Jan. 1, 1965).

A retarding potential technique was investigated that permits study of secondary processes occurring after ion acceleration in a time-of-flight mass spectrometer. By application of a retarding field near the end of the flight path, peaks due to neutral species and fragment ions formed after acceleration are separated from their parent ion peaks and displayed in the same panoramic mass spectrum. Charge exchange, collision-induced dissociation, and spontaneous (metastable) ion decomposition are easily observed. The identities of initial ions and fragment ions involved in secondary processes can be determined unambiguously without complications of peak overlap. (auth)

7392 ISOTOPE EFFECTS ON VIBRATIONAL TRANSITION PROBABILITIES. THE SCHUMANN-RUNGE ABSORPTION BANDS OF $^{16}O_2$ AND $^{18}O_2$. M. Halmann and I. Laulicht (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Phys., 42: 137-9(Jan. 1, 1965).

The integrated absorption intensities of the 4, 0 to 11, 0 bands of the Schumann-Runge system of $^{16}O_2$ and $^{18}O_2$ were measured at atmospheric pressure and compared with the Franck-Condon factors for these bands, calculated using a Morse potential and simple anharmonicity corrections. Bands of $^{18}O_2$ are about 1.5 times more intense than corresponding bands of $^{16}O_2$, while the calculated Franck-Condon factors of $^{16}O_2$ are 2 to 4 times as large as those for $^{18}O_2$. (auth)

7393 GASEOUS DIFFUSION. THE SYSTEMS He–Ar, Ar–Xe, AND He–Xe. A. P. Malinauskas (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 42: 156-9(Jan. 1, 1965). (ORNL-TM-941)

Relative values of the diffusion coefficients of the systems He–Ar, Ar–Xe, and He–Xe were determined over the temperature range 0 to 120°C by a two-bulb method. The experimental diffusion coefficients, at 1 atm pressure, can be described by the following equations: He–Ar: $\log_{10}D = 1.684 \log_{10}T - 4.2902$; Ar–Xe: $\log_{10}D = 1.955 \log_{10}T - 5.7807$; and He–Xe: $\log_{10}D = 1.720 \log_{10}T - 4.5251$. The apparatus was calibrated with the He–Ar diffusion data; the results for the system Ar–Xe are in essential agreement with the data reported by others, but the He–Xe diffusion coefficients are about 9% lower than previously published values. The present He–Xe coefficients are in good agreement, however, with results that have been determined from a consideration of the composition dependence of the viscosities of He–Xe mixtures. (auth)

7394 VIBRATIONAL SPECTRA OF ISOTOPIC NITRIC ACIDS. G. E. McGraw, D. L. Bernitt, and I. C. Hisatsune (Pennsylvania State Univ., University Park). J. Chem. Phys., 42: 237-44(Jan. 1, 1965).

The vibrational spectra of four isotopic nitric acid molecules including the ^{15}N and D species were obtained in the vapor and solid phases. The Raman spectra of anhydrous and wet normal nitric acid were also studied. Previous assignment of the fundamental modes was revised, and the spectra in the three phases were correlated. The potential barrier against internal rotation of the hydroxyl group was calculated to be 7.8 ± 0.1 kcal/mole in both the H and D acids. A set of least-squares fitted valence force constants, which reproduce the observed fundamentals with an average error of 0.6%, was derived. (auth)

7395 INHIBITED DISSOLUTION OF {100} SURFACES OF SINGLE CRYSTALS OF LITHIUM FLUORIDE. M. B. Ives and J. T. Plewes (McMaster Univ., Hamilton, Ont., Can.). J. Chem. Phys., 42: 293-6(Jan. 1, 1965).

A technique is described for the determination of the dissolution rates of {100} lithium fluoride surfaces in dilute aqueous solutions of ferric fluoride. The effect of ferric ion content of the etchant on the rate was found to be constant for ion concentrations substantially in excess of the optimum for the production of smooth-faced square etch pits at dislocations. The results correlate well with recent theories concerning the adsorption of ferric ions during etching. The effect of lithium fluoride undersaturation varies greatly from specimen to specimen and demonstrated the heterogeneous nature of hole nucleation in the close-packed surfaces. (auth)

7396 METHOD OF ADJUSTING FORCE CONSTANTS AND ITS APPLICATION TO H_2O, H_2CO, CH_2Cl, $[CH_2Cl_2]$ AND THEIR DEUTERATED MOLECULES. Takehiko Shimanouchi and Isao Suzuki (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 296-308(Jan. 1, 1965).

A new method for the adjustment of vibrational force constants is presented. It avoids some of the divergence difficulties that may be encountered in perturbation and least-squares procedures. The new method employs an efficient computer program to adjust an initial set of force constants in accordance with the requirement that each successive adjustment leads to a smaller sum of squared deviations between calculated and observed eigenvalues. Several variants of the procedure are given, and their application to a number of actual cases is discussed in detail. (auth)

7397 ON THE THEORETICAL CALCULATION OF VIBRATIONAL FREQUENCIES AND INTENSITIES OF POLYATOMIC MOLECULES: H_3^+, H_2D^+, HD_2^+, AND D_3^+. Norman T. Huff and Frank O. Ellison (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Phys., 42: 364-70(Jan. 1, 1965).

A straightforward method is described for calculating the fundamental vibrational frequencies and intensities for a polyatomic molecule starting with a theoretically obtained potential energy surface and associated electronic state wavefunction. Given the latter two quantities, this method is much easier to carry out than the common reverse problem of predicting force constants from observed frequencies and molecular dipole moment derivatives from absolute intensities. The proposed method can be programmed easily and generally to handle any polyatomic system for which a theoretical energy surface and electronic-state wave-function are available. An application to H_3^+ and its isotopic counterparts is described. (auth)

7398 CRYSTAL FIELDS AT RARE-EARTH IONS. Gerald Burns (IBM Zurich Research Lab., Zurich). J. Chem. Phys., 42: 377-90(Jan. 1, 1965).

Studies were made to determine why the calculated rare-earth crystal-field parameters do not agree with those determined experimentally. One way of stating the trouble is: Since the distance between the observer (rare-earth ion) and the charge distribution is not large compared to the extent of the charge distribution it is not a good approximation to replace the charge distribution by point moments. From numerical examples it is easy to see, for n = 4 and 6, that most of the contribution to the A_n^m sums comes from the parts of the surrounding ions that are closest to the rare-earth ions. Thus it becomes difficult to calculate the A_n^m's accurately. However, using this idea, agreement is obtained with the dependence of the V_n^m's on Z and some of the interrelationships between the different n terms. For the lattices usually used as hosts the A_4^4 sum cannot be calculated because of its sensitivity to the x-ray data and charge distribution parameters. However, by using nuclear quadrupole resonance data to eliminate calculating the actual lattice sum, good agreement is obtained between the measured V_4^4's and $(1-\alpha_2)\langle r^2\rangle A_4^4$. (P.C.H.)

7399 ELECTRON-IMPACT SPECTRA. Ausma Skerbele and Edwin N. Lassettre (Ohio State Univ., Columbus). J. Chem. Phys., 42: 395-401(Jan. 1, 1965).

Electron-impact spectra at zero scattering angle were obtained for nitrogen, carbon monoxide, water, ammonia, and benzene. Vibrational structure was resolved for the $a\,^1\pi_g$ state in nitrogen and two Rydberg transitions in water spectra. The results were compared with ultraviolet absorption data. (auth)

7400 CRYSTAL-FIELD SPLITTING IN Yb^{3+} CHELATES. W. G. Perkins and G. A. Crosby (Univ. of New Mexico, Albuquerque). J. Chem. Phys., 42: 407-14(Jan. 1, 1965).

Optical absorption and emission spectra of trivalent ytterbium in various chelates are reported. The experimental energy levels of Yb^{3+} were compared with predictions of electrostatic crystal-field theory and of a contact model of ligand-field theory. Good agreement was found between theory and experiment for the electrostatic crystal-field calculation. Poorer agreement was obtained using the ligand-field contact model calculation. The crystal-field calculation uses a single geometrical parameter θ. By using the calculations, x-ray results for other compounds, and the observed spectra, it was possible to obtain a reasonable estimate of the molecular geometry, which appears to be that of an octahedron distorted by shortening a threefold axis. (auth)

7401 NUCLEAR SPIN-SPIN COUPLING OF THE TYPE $J_{X\text{-}C\text{-}H}$. George W. Smith (General Motors Corp., Warren, Mich.). J. Chem. Phys., 42: 435-6(Jan. 1, 1965).

Evidence is presented supporting the view that excitation energy (ΔE) is a constant for the case of $J_{X\text{-}C\text{-}H}$ in compounds of the family $X(CH_2)_m$, where m = 2, 3, or 4. It was concluded that for $J_{X\text{-}C\text{-}H}$ the assumption ΔE = constant is favored over the calculation by summing bond energies. Data are tabulated. (P.C.H.)

7402 OXYGEN QUENCHING OF POSITRONIUM IN LIQUIDS. John Lee and G. J. Celitans (New England Inst. for Medical Research, Ridgefield, Conn.). J. Chem. Phys., 42: 437-8(Jan. 1, 1965).

Positronium lifetimes in several liquids that were thoroughly degassed by the usual vacuum freeze-thawing techniques are reported. The lifetimes were compared with the same liquids that were air saturated and oxygen saturated. The degassed liquids showed a slight decrease in lifetime with increase in density. It was implied from the results for positronium that either positronium diffuses with a thermal velocity, which may be estimated from the measured diffusion rate of oxygen and the ratio of masses, but is quenched by only a small fraction of the oxygen collisions, or that positronium is trapped in some way in the liquid, and the quenching rate is determined by the rate of diffusion of oxygen to the positronium. (P.C.H.)

7403 ANISOTROPIC ^{207}Pb MAGNETIC SHIELDING IN A SINGLE CRYSTAL OF WULFENITE, $PbMoO_4$. Paul C. Lauterbur (State Univ. of New York, Stony Brook) and John J. Burke. J. Chem. Phys., 42: 439-40(Jan. 1, 1965).

Results on the ^{207}Pb NMR spectrum in wulfenite, $PbMoO_4$, are reported. No attempt was made to align the crystallographic axes in the magnetic field. Instead, the more generally useful procedure of rotating the crystal about an arbitrarily oriented set of three mutually perpendicular axes was followed. The data, consisting of shieldings measured at 20° intervals, were fitted by a previously derived method, and the resulting coefficients were used to obtain the magnitudes and directions of the principal axes of the shielding tensor. The entire analysis was carried out with an IBM-1620 computer. For wulfenite the results are $\sigma_{\parallel}^{\circ} = -63 \pm 5$, $\sigma_{\perp}^{\circ} = 126 \pm 5$, and $\sigma_{Av} = -974 \pm 10$ ppm relative to saturated aqueous $Pb(NO_3)_2$. Pending the availability of accurate data on more compounds, it was noted that, adopting previous assumptions and estimates, the lead shielding in wulfenite indicates an average p admixture of about 10%, with about 1% greater p_z character than p_x or p_y, taking the z axis parallel to the c axis of the crystal. (P.C.H.)

7404 VIBRATIONAL RELAXATION OF O_2 IN O_2-D_2 MIXTURES AND OF H_2 AND D_2. Donald R. White (General Electric Research Lab., Schenectady, N. Y.). J. Chem. Phys., 42: 447-9(Jan. 15, 1965).

Shock-tube interferometry was used to observe vibrational relaxation of O_2 in $O_2 + D_2$ mixtures. From 300 to 850°K the shock-tube and previous ultrasonic relaxation times in atmosphere seconds are given by $\log_{10}(p\tau_{O_2-D_2}) = 27.3T^{-\frac{1}{3}} - 8.35$. Above 1500°K the relaxation time of O_2 was further shortened due to effects of chemical reaction or possibly to a resonant-energy exchange with the more rapidly excited D_2. Hydrogen vibrational relaxation was too rapid to be resolved, yielding $p\tau_{H_2} < 2 \times 10^{-6}$ atm·sec for T = 1400°K. The vibrational relaxation of deuterium appeared to be more complex than other diatoms studied and is not yet understood. However, it was observed that $p\tau_{D_2} < 6 \times 10^{-6}$ atm·sec at T = 1400°K. (auth)

7405 THERMAL DESORPTION OF Sr FROM W. T. E. Madey, A. A. Petrauskas, and E. A. Coomes (Univ. of Notre Dame, Ind.). J. Chem. Phys., 42: 479-85(Jan. 15, 1965).

Kinetics of the thermal desorption of Sr from W was studied. The field electron microscope was used to identify the state of adsorbate–substrate system. The activation energy for thermal desorption of Sr from W fell from 4.21 ± 0.22 ev/atom at zero Sr coverage to 1.78 ± 0.13 ev/atom at "monolayer" coverage. This latter value approached the heat of sublimation of bulk Sr (1.69 ev/atom). The desorption energies found using field-emission techniques deviated markedly from the extrapolated thermionic results of Moore and Allison near $\theta = 0$ and for $\theta > 0.5$. A linear relationship was found to exist between the activation energy for desorption and the logarithm of the pre-exponential factor in the rate equation $\kappa(kT/h)\exp(\Delta S^{\ddagger}/R)$. (auth)

7406 SPECTRUM AND STRUCTURE OF THE He_2 MOLECULE. I. CHARACTERIZATION OF THE STATES ASSOCIATED WITH THE UAO's 3pσ AND 2s. Marshall L. Ginter (Univ. of Chicago). J. Chem. Phys., 42: 561-8 (Jan. 15, 1965).

The He_2 band systems $3p\sigma$, $^{1,3}\Sigma_g^+ \rightarrow 2s$, $^{1,3}\Sigma_u^+$ are described. The rotational and vibrational constants of the 2s, $a^3\Sigma_u^+$, and $A^1\Sigma_u^+$ and $3p\sigma$, $c^3\Sigma_g^+$ states were improved and data for the A and c states extended from v = 1 to v = 3 and 4, respectively. The $3p\sigma$ $C^1\Sigma_g^+$ state (identified for the first time) was characterized through v = 5. The apparent dissociation energy of the $c^3\Sigma_g^+$ state was found to be ~0.7 ev too high to be consistent with the theoretical dissociation energy of He_2^+. If the D_0 value for He_2^+ is correct, large maxima must be present in the potential curves of a number of electronic states of He_2. The observed and expected behavior of states associated with npσ UAO's is also discussed. (auth)

7407 NUCLEAR MAGNETIC RESONANCE IN MOLTEN SALTS. II. CHEMICAL SHIFTS IN THALLIUM HALIDE–ALKALI HALIDE MIXTURES. Stefan Hafner and Norman H. Nachtrieb (Univ. of Chicago). J. Chem. Phys., 42: 631-6(Jan. 15, 1965).

The resonance frequency of the ^{205}Tl nucleus in molten solutions of thallous halides with corresponding alkali metal halides varied linearly with the mole fraction of the added alkali halide. The direction of the chemical shift depended on the radius of the alkali cation, being upfield for lithium and sodium halides and downfield for the halides of potassium, rubidium, and cesium relative to the pure thallous halide. For a given mole fraction of alkali halide, δ_{Tl} was a linear function of the alkali cation radius. The results provided information on the nature of the interactions between cations and anions in molten salts. The covalent interaction between Tl^+ and halide ions was decreased by alkali metal ions of small radius and increased by those of large radius. (auth)

7408 PHOTODESORPTION. R. E. Adams and E. E. Donaldson (Washington State Univ., Pullman). J. Chem. Phys., 42: 770-4(Jan. 15, 1965).

Monochromatic radiation with a wavelength between 2000 and 6000 Å is shown to desorb CO from surfaces of Fe, Ni, and Zr. The desorption efficiency has a maximum at 2700 Å for Ni, at less than 2500 Å for Zr, and in the visible region for Fe. Photodesorption from W and Mo was not detected. A suggested mechanism for photodesorption indicated that valuable information concerning surface binding can be obtained from refined measurements. (auth)

7409 EFFECTS OF TEMPERATURE AND DEUTERIUM SUBSTITUTION ON THE ELECTRON SPIN RESONANCE SPECTRA OF FREE RADICALS. M. R. Das and George K. Fraenkel (Columbia Univ., New York). J. Chem. Phys., 42: 792-4(Jan. 15, 1965).

Electron spin resonance measurements of the dihydropyrazine cation and related radicals were performed, which showed small but significant changes in the isotropic hyperfine splitting constants with temperature. N-deutero substitution caused shifts in the nitrogen and ring-proton splitting constants, and indicated anomalous deuterium splittings. Calculations indicated that both effects may arise from a vibrational mechanism. (M.C.G.)

7410 THERMAL CONDUCTIVITY OF AN EQUIMOLAR H_2O–D_2O MIXTURE. E. Spinner (London Univ.). J. Chem. Phys., 42: 812(Jan. 15, 1965).

In order to assess the importance of resonance transfer of energy of rotational excitation in the conduction of heat by polar gases, Baker and Brokaw (J. Chem. Phys., 40: 1525(1964)) studied an equimolar mixture of H_2O and D_2O. It is postulated that their conclusions may lack a firm experimental basis because the exact composition of the mixture, the presence and thermal conductivity of DOH, and the conductivity coefficients for collisions between unlike molecules are said to be undetermined. (M.C.G.)

7411 PHOSPHONIUM SALTS AND PHOSPHINE OXIDE ADDITION COMPOUNDS OF URANIUM(IV) AND URANIUM(VI). P. Gans and B. C. Smith (London Univ.). J. Chem. Soc.: 4172-6(Nov. 1964).

Tertiary phosphines reacted with uranium tetrachloride in ethanol to give crystalline diphosphonium hexachlorouranates(IV). Oxidation of these by air gave diphosphonium tetrachlorodioxouranates(VI), but oxidation by chlorine gave uranium tetrachloride-bis(phosphine oxide) addition compounds. Further oxidation by hydrogen peroxide gave uranyl chloride-bis(phosphine oxide) addition compounds. Features of the infrared spectra are reported. Uranium tetrachloride–phosphine and uranium tetrachloride–phosphine sulfide addition compounds were not obtained. (auth)

7412 REACTIONS OF URANIUM TETRACHLORIDE WITH 2,2'-BIPYRIDYL AND o-PHENANTHROLINE. P. Gans and B. C. Smith (London Univ.). J. Chem. Soc.: 4177-9(Nov. 1964).

Solutions of uranium tetrachloride in alcohols undergo solvolysis in the presence of 2,2'-bipyridyl (bipy) and o-phenanthroline (phen). The hexachlorouranates(IV), $(bipyH)_2UCl_6$, and $(phenH)_2UCl_6$, and the addition compounds, $UCl_4OEt,bipy_2$ and $UCl_4OEt,phen_2$, were isolated. Reactions in dimethylformamide (DMF) gave the addition compounds $2UCl_4{\cdot}5DMF$ and $UCl_4.phen_2$, and oxidation of the dimethylformamide solutions gave the tetrachlorodioxouranates(VI), $(bipyH)_2UO_2Cl_4$ and $(phenH)_2UO_2Cl_4$. (auth)

7413 THE KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XIII. ISOTOPE EFFECTS IN THE ACID-CATALYSED HYDROGEN EXCHANGE OF 1,3,5-TRIMETHOXYBENZENE. B. D. Batts and V. Gold (King's Coll., London). J. Chem. Soc.: 4284-92(Nov. 1964).

The ratio of the rates of the simultaneous loss of tritium and deuterium from 1,3,5-trimethoxybenzene labeled with both isotopes was studied in aqueous perchloric acid and acetate buffer solutions. This ratio was shown to be independent of the concentration of the catalyzing acid. In D_2O–$DClO_4$ solution the loss of tritium was 1.68 times faster than in H_2O–$HClO_4$ solutions of the same acid concentration. In deuteriated acetate buffer solution the acetic acid-catalyzed reaction (general acid catalysis) was 1.46 times slower than in the light medium. On the basis of a reasonable representation of the reaction path, isotope effects for the component steps of the overall reaction were deduced. These effects should be interconnected if a common reaction mechanism holds for both forms of catalysis, and this prediction was borne out by the data. (auth)

7414 THE SPECTRA AND STABILITY OF SOME NEPTUNIUM COMPLEX IONS IN WATER AND METHANOL. I. Gainar and K. W. Sykes (London Univ.). J. Chem. Soc.: 4452-9(Nov. 1964).

The formation constants for $NpO_2^+Cl^-$ and $NpO_2^+NO_3^-$ were found by cation-exchange to be 0.51 ± 0.06 and 0.56 ± 0.06 $mole^{-1}$ l, respectively, in aqueous perchlorate solution of ionic strength 2.0 at 25°C. Absence of complex formation thus cannot be the reason why these anions do not affect the spectrum of Np(V) in aqueous solution. Even in methanol, chloride caused no detectable charge-transfer or ligand-field effects in the range from 225 to 1000 mμ, though the 980 mμ peak was shifted to 978 mμ by the change of solvent. From its relationship to known anion–cation exchange-transfer bands, the ultraviolet absorption of Np(IV) in aqueous perchlorate solution was assigned to solvent–cation charge transfer, and this was confirmed by the fact that change of solvent from water to methanol shifted the band in accordance with the difference in solvent ionization potential. The effect of sulfate on the charge-transfer and ligand-field bands, in water and in methanol, suggested that solvent molecules in the inner sphere are involved. Similar spectra of Fe(III) and Eu(III) in water and methanol were noted. Neptunium(VI) did not interact strongly with nitrate ion in water, but the anion–cation charge-transfer band of this system was clearly observed in methanol. (auth)

7415 CRYSTAL CHEMISTRY OF SOME TECHNETIUM-CONTAINING OXIDES. O. Muller, W. B. White, and

R. Roy (Pennsylvania State Univ., University Park). J. Inorg. Nucl. Chem., 26: 2075-86(Dec. 1964).

The crystal chemistry of technetium was investigated in a series of simple binary and ternary oxide structures. An investigation of the system Tc–O under controlled conditions revealed only one intermediate compound. Technetium-containing spinels could be synthesized in which technetium is on the octahedral sites. Technetium enters the B-sites in ABO_3 compounds yielding perovskite, hexagonal $BaTiO_3$, and pyrochlore structures. Three rare earth technetium pyrochlores with the formula $Ln_2Tc_2O_7$ were prepared. The radius of Tc^{4+} was found to be 0.67 Å. (auth)

7416 MAGNETIC PROPERTIES OF ZIRCONIUM (III) AND HAFNIUM (III) IODIDES. W. A. Baker, Jr., and A. R. Janus (Syracuse Univ., N. Y.). J. Inorg. Nucl. Chem., 26: 2087-97(Dec. 1964).

Zirconium (III) iodide and hafnium (III) iodide were prepared by aluminum reductions of the corresponding tetrahalides. Green and black species of both compounds were isolated. The magnetic susceptibilities of these compounds were measured over the temperature range from 100 to 300°K by the Gouy method. A correlation of observed magnetic and structural properties is given in terms of competing ferromagnetic and antiferromagnetic interactions in the lattice. The visible absorption spectrum was measured for species obtained on dissolution of zirconium (III) iodide in water. Absorption bands were assigned for what is proposed to be the hexaquozirconium (III) ion and a less stable iodinated species of the aquozirconium (III) ion. (auth)

7417 REACTIONS OF ATOMIC CARBON WITH π-BONDED INORGANIC MOLECULES. J. Dubrin, C. MacKay, M. L. Pandow, and R. Wolfgang (Yale Univ., New Haven and Haverford Coll., Haverford, Penna.). J. Inorg. Nucl. Chem., 26: 2113-22(Dec. 1964). (NYO-1957-47)

Atomic carbon (^{11}C) produced by nuclear transformations was reacted with O_2, CO, CO_2, SO_2, N_2, N_2O, NO, and NO_2. With O_2, CO, CO_2, and SO_2, ^{11}CO was the only significant product. This was true even in liquid oxygen where there was no three-body restriction on CO_2 formation. These findings suggested that the dominant mode of attack is "end-on" rather than by the usual "sideways π-complex" mode. An examination of the molecular orbitals involved indicated that this should in general be the preferred mechanism of carbon atom attack on π-bonded inorganic molecules. With N_2, N_2O, and NO the carbon atom could form a strong bond at either end of the molecule. In accordance with this both ^{11}CO and ^{11}CN were observed as major products. With NO_2, ^{11}CO was the major product, again as required by the "end-on" attack mechanism. These reactions occurred with both hot and thermalized carbon atoms. Thus both hot and thermal ^{11}C can undergo the exoergic reactions with O_2 to form ^{11}CO and with N_2O to give ^{11}CO and ^{11}CN. By contrast the endoergic process in which ^{11}C combines with N_2 to form ^{11}CN occurs only with hot atoms. (auth)

7418 EUROPIUM MIXED LIGAND COMPLEXES DERIVED FROM DIBENZOYLMETHANE AND CARBOXYLATE ANIONS. R. G. Charles (Westinghouse Research Labs., Pittsburgh). J. Inorg. Nucl. Chem., 26: 2195-9(Dec. 1964).

In the presence of acetate, propionate, or benzoate ions, trivalent europium and dibenzoylmethane react to give the mixed ligand complexes $(C_{15}H_{11}O_2)_2EuOCOR$, rather than the normal chelate $(C_{15}H_{11}O_2)_3Eu$. The thermal properties of the solid mixed ligand complexes were investigated by thermogravimetry, differential thermal analysis, and thermomanometric analysis. (auth)

7419 DIMETHYL SULPHOXIDE COMPLEXES OF TITANYL, ZIRCONYL, AND THORIUM PERCHLORATES. V. Krishnan and C. C. Patel (Indian Inst. of Science, Bangalore). J. Inorg. Nucl. Chem., 26: 2201-6(Dec. 1964).

$TiO \cdot 5DMSO(ClO_4)_2$, $ZrO \cdot 8DMSO(ClO_4)_2$, and $Th \cdot 12DMSO(ClO_4)_4$ were prepared by reaction of the respective metal perchlorates with an excess of dimethyl sulfoxide (DMSO). The last two complexes yielded $ZrO \cdot 6DMSO(ClO_4)_2$ and $Th \cdot 6DMSO(ClO_4)_4$ on heating around 185°C, while the titanyl complex exploded at 190°C. The extra DMSO molecules in the zirconyl and thorium complexes seemed to be held in the lattice. In the parent complexes, the coordinated DMSO molecules were bonded by oxygen to the metal atoms while in the DMSO complexes of zirconyl and thorium perchlorates, obtained by heating at 185°C, the bonding involved sulfur, indicating a change in the bonding during the process of heating. (auth)

7420 THE REACTION BETWEEN DIOXANE AND HYDRATED LANTHANIDE NITRATES. G. Vicentini, M. Perrier, and E. Giesbrecht (Universidade, Sao Paulo, Brazil). J. Inorg. Nucl. Chem., 26: 2207-10(Dec. 1964).

The reactions between dioxane and hydrated lanthanide nitrates are described. The compounds of formula $Ln(NO_3)_3 \cdot 2H_2O \cdot C_4H_8O_2$ (Ln = La, Ce), $Ln(NO_3)_3 \cdot 2H_2O \cdot 2C_4H_8O_2$ (Ln = Pr, Nd, Sm), and $Ln(NO_3)_3 \cdot 3H_2O \cdot 2.5C_4H_8O_2$ (Ln = Y, Gd, Tb, Dy, Ho, Er, Tm, Yb) were prepared and their infrared spectra studied. (auth)

7421 THIOCYANATO DERIVATIVES OF CHROMIUM, MOLYBDENUM AND TUNGSTEN HEXACARBONYLS. A. Wojcicki and M. F. Farona (Ohio State Univ., Columbus). J. Inorg. Nucl. Chem., 26: 2289-90(Dec. 1964).

In order to assess the effect of the metal charge on the nature of the thiocyanato-metal attachment, the anionic thiocyanato-pentacarbonyl complexes of tungsten, molybdenum, and chromium were prepared. It was concluded that a decrease in the charge changes the bonding from M–SCN to M–NCS. (M.C.G.)

7422 RARE EARTH SALICYLALDEHYDE CHELATES. R. G. Charles (Westinghouse Research Labs., Pittsburgh). J. Inorg. Nucl. Chem., 26: 2298-2300(Dec. 1964).

Work on the preparation and properties of rare earth salicylaldehyde chelates is reported. It was found that the compounds can be readily formed, in excellent yields, by reaction of trivalent lathanide ions with sodium salicylaldehyde. The compounds were substantially pure and free of sodium for La, Ce, Pr, Nd, Sm, and Eu. The other rare earths gave derivatives containing significant amounts of sodium. Thermogravimetric curves and infrared spectra were obtained. (M.C.G.)

7423 NEW EUROPIUM β-DIKETONE CHELATES. S. M. Lee and L. J. Nugent (Electro-Optical Systems, Inc., Pasadena, Calif.). J. Inorg. Nucl. Chem., 26: 2304-6(Dec. 1964).

Methods for preparing europium β-diketone chelates are described. Observed differences in the empirical formulas, which presumably depend on the nature and the concentration of both the Lewis base and the bidentate ion, are discussed. The chelates were prepared by mixing an alcohol solution of a europium salt with a diketone and a Lewis base. (M.C.G.)

7424 DIELECTRIC CONSTANTS OF MIXTURES OF TRI-n-BUTYL PHOSPHATE AND WATER AND TRI-n-BUTYL PHOSPHATE AND MINERAL ACIDS. J. H. Miles (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 26: 2308-9(Dec. 1964).

Measurements were made of the dielectric constant of solutions of water or acids in TBP. A linear relation between dielectric constant and water concentration at ambient temperature (18°C) was observed. There was a rough correlation between the dielectric constant of the anhydrous acid in TBP and that of the pure liquid acid. (M.C.G.)

7425 ELECTROWINNING RARE-EARTH AND URANIUM METALS FROM THEIR OXIDES. T. A. Henrie (Bureau of Mines, Reno, Nev.). J. Metals, 16: 978-81(Dec. 1964).

Cerium, lanthanum, and uranium were electrowon on a practical laboratory scale directly from their oxides in a fluoride melt. Careful control of the oxide feed rate and of the temperature of reaction are requisite to obtain good coalescence and yield. The technique, which is described, is relatively simple and can, no doubt, be modified to prepare other reactive metals. (auth)

7426 DETERMINATION OF STRUCTURE BY ISOTOPIC SUBSTITUTION IN MOLECULES WITH SYMMETRICALLY EQUIVALENT ATOMS. Ara Chutjian (Univ. of

California, Berkeley). J. Mol. Spectry., 24: 361-70(Dec. 1964). (UCRL-11230)

Kraitchman's equations relate changes in moments of inertia in single isotopic substitution to the location of the substitute atom. These relations were extended to the case of multiple isotopic substitution on a set of symmetrically equivalent atoms. (auth)

7427 SECOND DISSOCIATION CONSTANT OF DEUTERIOPHOSPHORIC ACID IN DEUTERIUM OXIDE FROM 5 TO 50°. STANDARDIZATION OF A pD SCALE. Robert Gary, Roger G. Bates, and R. A. Robinson (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 68: 3806-9(Dec. 1964).

The second dissociation constant of deuteriophosphoric acid in deuterium oxide was determined from electromotive force measurements of a cell without liquid junction from 5 to 50°C. Thermodynamic quantities for the second dissociation process of this acid were calculated. Values of $-\log(\alpha_D + \gamma_{Cl^-})$ and the conventional pa_D values for the equimolal (0.025 M) $KD_2PO_4-Na_2DPO_4$ buffer solutions were established. (auth)

7428 THE USE OF SODIUM BOROHYDRIDE IN CATALYTIC DEUTERIUM EXCHANGE REACTIONS. G. E. Calf and J. L. Garnett (Univ. of New South Wales, Kensington, Australia). J. Phys. Chem., 68: 3887-9(Dec. 1964).

Preparation of active transition metal catalysts for deuterium exchange reactions, by reduction in aqueous media with sodium borohydride, is described. There was a general improvement in isotope incorporation of the aromatics from the hydride technique for almost all catalysts studied. (M.C.G.)

7429 NUCLEAR MAGNETIC RESONANCE LINE SHAPE STUDY IN METALLIC POWDERS IN PRESENCE OF AXIALLY SYMMETRIC ANISOTROPIC KNIGHT SHIFT. F. Borsa and R. G. Barnes (Ames Lab., Ames, Iowa). J. Phys. Chem. Solids, 25: 1305-16(Dec. 1964). (IS-885)

The absorption and dispersion line shapes in a powder sample of a metal displaying axially symmetric anisotropic Knight shift were studied. An unambiguous way to derive from the experimental data precise values for K_{ax}, K_{iso}, and the width and shape of the zero-field symmetric broadening is presented and applied to the cases of tin and cadmium metals for different temperatures. Even a small temperature dependence of the different parameters can be detected, and the usefulness of such measurements to obtain information on the band structure of non-cubic metals is discussed. (auth)

7430 MAGNETIC PROPERTIES OF A NUMBER OF DIVALENT TRANSITION METAL TUNGSTATES, MOLYBDATES, AND TITANATES. L. G. Van Uitert, R. C. Sherwood, H. J. Williams, J. J. Rubin, and W. A. Bonner (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem. Solids, 25: 1447-51(Dec. 1964).

Magnetization data taken between room temperature and 1.4°K are reported for $M^{II}M^{VI}O_4$ compounds (where M^{II} = Mn, Co, Ni, and Cu and M^{VI} = W and Mo), for $Li_2M(MoO_4)_3$ (where M = Co, Ni, and Cu), and for $CoTiO_3$. The dependence of Néel temperature on the electronegativity of the cation present is discussed. (auth)

7431 CRYSTALLINE AND MAGNETIC PROPERTIES OF COMPLEX GARNETS OF YTTRIC AND CERIC RARE EARTHS. Gérard Villers and Paul Lombard (CNRS, Bellevue, France). J. Phys. (Paris), 25: 853-4(Oct. 1964). (In French)

The crystalline and magnetic properties of garnets having the molecular relation $(5-x)\ Fe_2O_3 \cdot xMe_2O_3 \cdot 1.5\ Y_2O_3 \cdot 1.5\ Nd_2O_3$, Me being either scandium or chromium, are studied. From these properties, a value for the magnetic moment of the Nd^{3+} ion can be deduced. (auth)

7432 TWO-QUANTUM RESONANCE SPECTRUM OF A NUCLEAR SPIN I = 1 IN AN ANISOTROPIC MEDIUM. J. P. Cohen-Addad (Institut Fourier, Grenoble, France). J. Phys. (Paris), 25: 863-7(Oct. 1964). (In French)

A nuclear spin I = 1, whose average value of the quadrupole interaction energy is different from zero, is considered. It is shown that it is possible to observe a narrow two quantum resonance signal, although the corresponding quantum resonance lines are broad. (auth)

7433 THE 1962 He^3 SCALE OF TEMPERATURES. I. NEW VAPOR PRESSURE COMPARISONS. S. G. Sydoriak and R. H. Sherman (Los Alamos Scientific Lab., N. Mex.). J. Res. Natl. Bur. Std., 68A: 547-58(Nov.-Dec. 1964).

A comparison of ^3He and ^4He vapor pressures, (P_3, P_4), was made in an apparatus designed to reduce the number and magnitude of corrections associated with the refluxing film in the ^4He pressure sensing tube and the attached bulb. The critical pressure of ^3He was redetermined to be at 873.0 ± 1.5 mm Hg at 0°C and standard gravity; the corresponding temperature as measured by a ^4He thermometer is 3.3240 ± 0.0018°K on the 1958 ^4He scale. Empirical interpolation equations containing only P_3 and P_4 are described by means of which existing P_4 measurements may be converted to an equivalent P_3. A comparison was made between this interpolation and a conversion in which the 1958 ^4He and 1962 ^3He scales are used as parameters. Deviations between the two procedures are within the estimated errors of the (P_3, P_4) measurements. In subsidiary experiments on techniques for ^4He thermometry a typical vapor pressure bulb arrangement was tested. It is shown that the refluxing film introduces a heat flux, $\dot{Q}_f$, and a resulting Kapitza temperature drop, ΔT_k, between the He(II) and its container, which may amount to many millidegrees. The feasibility of calculating ΔT_k for a particular ^4He vapor pressure bulb was studied. The necessity of measuring $\Delta T_k/\dot{Q}_f$ at least once in situ is pointed out. In addition, it is necessary to redetermine the film flow rate periodically at the same time that ^4He vapor pressure measurements are being made. (auth)

7434 THE 1962 He^3 SCALE OF TEMPERATURES. III. EVALUATION AND STATUS. T. R. Roberts, R. H. Sherman, and S. G. Sydoriak (Los Alamos Scientific Lab., N. Mex.). J. Res. Natl. Bur. Std., 68A: 567-78(Nov.-Dec. 1964). (LADC-6217)

The 1962 ^3He Scale of Temperatures is evaluated both as to its precision and its deviations from the thermodynamic Kelvin Scale. Various thermodynamic quantities of ^3He consistent with the 1962 ^3He Scale are derived and listed. The correction to an observed vapor pressure for small amounts of ^4He is discussed and tabulated. A description is given of the method of multiple variable least squares analysis used for deriving the final scale equation and for re-analysis of isotherm data. Finally the present status of the 1962 ^3He Scale is discussed along with some considerations for the future. (auth)

7435 THE 1962 He^3 SCALE OF TEMPERATURES. IV. TABLES. R. H. Sherman, S. G. Sydoriak, and T. R. Roberts (Los Alamos Scientific Lab., N. Mex.). J. Res. Natl. Bur. Std., 68A: 579-88(Nov.-Dec. 1964). (LADC-6218)

The detailed tables of the 1962 ^3He Scale of Temperatures are presented. The vapor pressure of ^3He is tabulated in steps of 1 millidegree from 0.2 to 3.324°K, the critical temperature. A table giving temperature, to 0.1 millidegree, as a function of pressure is included, as well as the temperature derivative of the vapor pressure. (auth)

7436 ABSOLUTE ISOTOPIC ABUNDANCE RATIO AND THE ATOMIC WEIGHT OF A REFERENCE SAMPLE OF COPPER. William R. Shields, Thomas J. Murphy, and Ernest L. Garner. J. Res. Natl. Bur. Std., 68A: 589-92(Nov.-Dec. 1964).

An absolute value for the isotopic abundance ratio of copper was obtained by thermal emission mass spectrometry. Samples of known abundance ratio, prepared from nearly pure separated copper isotopes, were used to calibrate the mass spectrometers. The results yield an absolute value of $^{63}Cu/^{65}Cu = 2.2440 \pm 0.0021$ and an atomic weight of 63.54555 ± 0.00040 ($^{12}C = 12$). The indicated uncertainties are overall limits of error based on 95% confidence limits for the mean and on allowances for the effects of known sources of possible systematic error. A companion study of the $^{63}Cu/^{65}Cu$ ratio in natural materials has shown that there is significant variation in some rare secondary minerals. (auth)

7437 ABSOLUTE ISOTOPIC ABUNDANCE RATIO AND THE ATOMIC WEIGHT OF BROMINE. Edward J. Catanzaro, Thomas J. Murphy, Ernest L. Garner, and William R. Shields. J. Res. Natl. Bur. Std., 68A: 593-9(Nov.-Dec. 1964).

An absolute value is obtained for the isotopic abundance ratio of bromine using thermal emission mass spectrometers calibrated for bias by the use of samples of known isotopic composition prepared from nearly pure separated bromine isotopes. The resulting absolute $^{79}Br/^{81}Br$ ratio is 1.02784 ± 0.00190 which yields an atomic weight (^{12}C = 12) of 79.90363 ± 0.00092. The indicated uncertainties are overall limits of error based on 95% confidence limits for the mean and allowances for the effects of known sources of possible systematic error plus a component to cover possible natural variations in isotopic composition although no provable variations were noted among the $^{79}Br/^{81}Br$ ratios of 29 commercial and natural samples. Mass spectrometric determinations of the atomic weights of bromine and silver give a combining weight ratio of AgBr/Ag = 1.740752. (auth)

7438 SOME PROPERTIES OF THE ORWO-K 5 NUCLEAR EMULSION. U. Krecker (Forschungsstelle fur Physik Hoher Energie, Deutsche Akademie der Wissenschaften, Berlin). Kernenergie, 7: 721-4(Oct. 1964). (In German)

Nuclear emulsions of ORWO-K 5 type, 700 μ in thickness were studied as to their sensitivity, distortions, and spurious scattering. The sensitivity of the tracks having minimum ionization is found to be about 25 blobs per 100μ. Distortions and spurious scattering of ORWO-K 5 emulsion are of the same order of magnitude as those of the nuclear emulsions of NIKFI or ILFORD type. Spurious scattering was found to be strongly dependent on the dip angle of the measured track. ORWO-K 5 emulsions show a higher grain noise than the other types of emulsion. (auth)

7439 ISOTOPIC EXCHANGE OF OXYGEN OF VANADIUM PENTOXIDE WITH SULFUR DIOXIDE AND TRIOXIDE. L. A. Kasatkina and V. I. Shustov (Mendeleev Inst. of Chemistry and Tech., Moscow). Kinetika i Kataliz, 5: 945-8(Sept.-Oct. 1964). (In Russian)

^{18}O in V_2O_5 readily exchanged with oxygen in SO_3 or SO_2. The reaction took place chiefly on the surface of the V_2O_5. At 450°C the rate was 500 to 700 times that with oxygen or water vapor and was of the same order of magnitude as the oxidation rate. (tr-auth)

7440 RECENT ACHIEVEMENTS IN INORGANIC CHEMISTRY. THE CHEMISTRY OF LANTHANIDES. Andor Almásy (Nehézvegyipari Kutató Intézet, Veszprém, Hungary). Magy. Tud. Akad. Kem, Tud. Oszt. Kozlemen., 22: 15-46(1964). (In Hungarian)

A review of the literature on rare earth chemistry is given including references to publications after 1960 on the subject. The production, properties, and uses in maser research of rare earths and their compounds are discussed. The reactions of rare earths with each other and alloys of rare earths with group III, group I, group IV, group V, group VI, group VII, and group VIII metals are discussed. Consideration is also given to hydration, hydrolysis, and hydroxide formation of rare earth ions. Space is devoted to production and properties of rare earth refractory compounds and halides. Rare earth complexes and their separation are also discussed. (BBB)

7441 INTERNATIONAL SYMPOSIUM ON COMPOUNDS OF INTEREST IN NUCLEAR REACTOR TECHNOLOGY, [AUGUST 3-5, 1964, UNIVERSITY OF COLORADO, BOULDER]. NUCLEAR METALLURGY, VOLUME X. J. T. Waber, P. Chiotti, and W. N. Miner, eds. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 1-798(1964). New York AIME. $15.00. (CONF-506)

Forty-eight papers and four abstracts of papers presented at the International Symposium on Compounds of Interest in Nuclear Reactor Technology are given. Oxides were not included in the considerations. Separate abstracts were prepared for 36 papers. The remaining 12 papers were previously abstracted in NSA and appeared as abstracts Vol. 18: 24137, 32046, 35990, 39820, 39821, 39897, 44224, 44225, 44226, 44227, 44228, and 44229. (M.C.G.)

For abstracts of individual papers see: 7442, 7443, 7444, 7445, 7446, 7447, 7448, 7449, 7450, 7451, 7452, 7453, 7454, 7455, 7456, 7457, 7458, 7459, 7460, 7461, 7462, 7463, 7464, 7465, 7466, 7467, 7468, 7469, 7470, 7941, 7942, 7943, 7944, 7988, 7989, and 7990.

7442 PROPERTIES OF THE CARBIDES OF THE TRANSITION METALS. P. Costa and R. R. Conte (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 3-27(1964).

A bibliographic work on published experiments seemed to show that the value of the density of states at the Fermi level for the NaCl-type carbides of a given series of transition metals should be half way between the IVa group and the Va group compound. This minimum was associated with a minimum in the density of the d-states distribution given by a tight binding calculation. Some experiments were made to complete or check the published data and see whether they fit with this description. Magnetic susceptibility, resistivity and thermoelectric power of carbon defective TiC, VC, YC, and binary compounds between TiC and TaC were determined. The electronic specific heat of TiC, TaC, and a TiC–TaC binary compound were measured. (auth)

7443 THE BAND STRUCTURE OF TiH_2. Kazuo Gesi (Japan Atomic Energy Research Inst., Tokyo), Yutaka Takagi, Takashi Takeuchi, and Seiichiro Noguchi. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 45-50(1964).

A possible energy band scheme for TiH_2 was proposed to interpret the physical phenomena related to the tetragonal-to-cubic phase transition of this compound. The scheme is essentially the same as that appropriate for semi-metals, namely, a valence band and a conduction band slightly overlap each other and the Fermi level lies near the overlapping position. Assuming a suitable change in the band shape through transition, it is shown that the temperature dependence of the magnetic susceptibility, electrical resistivity, and Hall coefficient, and the amount of anomalous entropy can be well explained, at least, qualitatively. (auth)

7444 RELATION OF BONDING AND ELECTRONIC BAND STRUCTURE TO THE CREATION OF LATTICE VACANCIES IN TiO, TiN AND TiC. Stephen Paul Denker (Columbia Univ., New York). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 51-62(1964).

The relationship between bonding and electronic band structure in TiC, TiN, and TiO was examined and it was found to be energetically favorable for TiN and TiO lattices to contain high vacancy concentrations at equilibrium. The electronic contribution to cohesive energy of a solid depends on the character of occupied orbitals or bands. A compound in which electrons largely occupy low-energy or bonding orbitals is more stable than one in which a significant fraction of valence electrons must also occupy high-energy or antibonding orbitals. The large concentration of lattice vacancies in TiN and TiO allows crystallization as defective rock-salt type structures, emptying high-energy orbitals by reducing the effective number of valence electrons, which lowers the Fermi energy. Thus, structural stability and mechanical properties of TiO, TiN, and TiC can be related to the position of the Fermi level, which for 100% dense crystals of TiN and TiO would be forced to lie across antibonding levels. Consideration of energy band calculations showed that lattice vacancies lower the Fermi energy by an amount (1.75 ev for TiO) that exceeds the total energy required to create a single titanium or oxygen vacancy (0.31 ev). In this process primarily antibonding orbitals are emptied and for stoichiometric TiO a net reduction of about 1.1 ev in the free energy at absolute zero was calculated. (auth)

7445 MAGNETIC PROPERTIES OF SOME REFRACTORY URANIUM COMPOUNDS. M. Allbutt, A. R. Junkison, and R. M. Dell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Met. Soc., Am. Inst. Mining, Met.

Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 65-81(1964).

Preparation of several binary compounds of uranium with nitrogen, phosphorus, and sulfur is described. The existence of three phases, UP, U_3P_4, and UP_2, in the uranium-phosphorus system and a beta-U_2N_3 phase in the nitrogen system was confirmed. Paramagnetic susceptibilities of these compounds, together with UN, UP, and US, were measured. In all cases a Curie-Weiss law was obeyed and all exhibited magnetic ordering at low temperatures. Curie temperatures are listed for ferromagnets US, beta-U_2N_3, and U_3P_4, and Néel temperatures for antiferromagnets, UN, UP, and UP_2. Susceptibilities, magnetic moments, and magnetic ordering are discussed and a comparison noted between the temperature independent susceptibility of UC and UCl_6^{-2}. It was conjectured that while an ionic model may be adequate for US, considerable covalent character is present in the bonding of nitrides, phosphides, and carbides. (auth)

7446 MAGNETIC TRANSITIONS IN URANIUM AND PLUTONIUM MONONITRIDES, MONOCARBIDES AND SESQUICARBIDES. P. Costa, R. Lallement, F. Anselin, and D. Rossignol (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 83-91(1964).

Resistivity and thermoelectric power measurements showed anomalies that indicated the presence of magnetic transformations in UN, U_2C_3, PuN, and Pu_2C_3. These results and previous results on UC and PuC are discussed. (auth)

7447 TERNARY BORIDES WITH THE CUBIC CHROMIUM CARBIDE STRUCTURE. H. H. Stadelmaier (North Carolina State Coll., Raleigh, N. C.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 159-66(1964).

Cobalt and nickel were found to form borides with the $Cr_{23}C_6$ structure in a large number of ternary systems. The published information on these phases, referred to as τ, was reviewed and supplemented with new results. The borides are represented by $T_{23-m}M_mB_n$, where T is Co or Ni, M is a nontransitional metal or a group IV or V transition metal. The arrangement of M in the lattice is ordered, and the M contents lie between m = 2 and 3.5. The boron content ranges from n = 5 to 12. The addition of M follows the known rules for the addition of the second element in electron compounds with copper. (auth)

7448 THERMODYNAMIC PROPERTIES OF TRANSITION METAL DIBORIDES. Larry Kaufman (ManLabs, Inc., Cambridge, Mass.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 193-213 (1964).

An integrated thermodynamic description of TiB_2, ZrB_2, HfB_2, NbB_2, and TaB_2 is presented. Information is included on the integral thermodynamic properties as well as component vapor pressures and rates of vaporization. This development was applied in computing the occurrence of congruency phenomena and maximum metal and boron solubility limits of the diboride phase. (auth)

7449 THERMODYNAMICS OF THE U_2N_3 PHASE REGION. Josef Bugl and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 215-24(1964).

Thermodynamic functions for the formation of U_2N_3 from UN and nitrogen were calculated on the basis of vapor pressure measurements over UN-U_2N_3 mixtures, and partial molal quantities for the solution of nitrogen in U_2N_3 were determined. From the latter, integrated thermodynamic functions for the solution of nitrogen in U_2N_3 were calculated. (auth)

7450 THERMODYNAMICS OF THE URANIUM-NITROGEN SYSTEM. P. E. Lapat and R. B. Holden (United Nuclear Corp., New Haven). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 225-36(1964).

A continuous vacuum balance technique was used to measure equilibrium decomposition pressures of U_2N_3 from 600 to 1100°C and N/U ratios from 1.7 down to the two-phase region UN + U_2N_3. UN data were also obtained at 1073°C for slightly hyperstoichiometric compositions. Some of the phase boundaries of the two nitrides were located. The partial molal heats and entropies of solution of N_2 in single-phase "U_2N_3" were calculated as a function of composition. The heat of decomposition of "U_2N_3" according to the reaction x"U_2N_3" = y"UN" + N_2 was determined to be 57 kcal/mole of N_2, which is in excellent agreement with a previously reported value of 58 kcal/mole of N_2. (auth)

7451 THERMODYNAMIC PROPERTIES OF URANIUM AND THORIUM MONOSULFIDE. E. D. Cater (Argonne National Lab., Ill.), R. J. Thorn, and R. R. Walters. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 237-44(1964).

Various thermochemical properties of uranium and thorium sulfides were investigated. These were compiled, analyzed, and intercompared and new values reported. Previous vapor pressure and mass spectrometric measurements of uranium monosulfide in the temperature range of 1840 to 2770°K gave the following free energy relationships: ΔF_f° (US,s) = 64.0T − 268,000 (cal/mole) and ΔF_f° (US,g) = 38.8T − 152,000 (cal/mole). The absolute entropies calculated from these data at 2300°K are 45.1 and 83.4 e.u. respectively for solid and gaseous uranium monosulfide. Preliminary vapor pressure measurements of thorium monosulfide in the temperature range of 1935 to 2464°K gave an estimated total effective pressure, p_e, of thorium monosulfide (calculated as if the vapor species were all ThS) as $\log p_e$ (atm) $\cong 7.7 - [(3{,}366 \times 10^4)/T]$. Thorium and uranium monosulfide were found to form solid solutions in which the lattice parameter, a_o, varies linearly with the mole fraction of thorium monosulfide. (auth)

7452 A COMPARISON OF THE CALCULATED AND OBSERVED VAPORIZATION BEHAVIOR OF THE URANIUM DICARBIDE PHASE. C. B. Alcock (Imperial Coll. of Science and Tech., London), H. A. Eick, E. G. Rauh, and R. J. Thorn. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 257-65(1964).

Two previous measurements of the partial pressure of uranium in equilibrium with uranium dicarbide were essentially in agreement, but disagreed with the calorimetric measurements of the heat and entropy of formation by factors as large as forty. One study also suggested that the dicarbide loses carbon preferentially to leave a residue of monocarbide, which supposedly vaporizes congruently. All of these observations can be brought into agreement provided that the principal gaseous species above $UC_{1.8}$ is gaseous dicarbide. Although the existence of the gaseous UC_2 was established previously in a mass spectrometric study, its concentration was somewhat uncertainly known because of the possibility of its fragmentation by the ionizing electrons. To investigate more thoroughly the concentration, a mass spectrometric investigation was effected. It was found in this study that the gaseous dicarbide was, in fact, relatively unimportant, but that the most intense and persistent gaseous species was carbon monoxide. In addition it was found by x-ray examination of surfaces of dicarbide from which vaporization had occurred that carbon was precipitated on the surface. Therefore it was concluded that the vaporization of uranium dicarbide is a complex non-equilibrium process in which carbon is lost preferentially via carbon monoxide and diffusion of uranium to the surface is sufficiently slow to be decisive. (auth)

7453 THERMODYNAMIC PROPERTIES OF TRANSITION METAL MONOCARBIDES. Larry Kaufman and Ann Sarney (ManLabs, Inc., Cambridge, Mass.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 267-78(1964).

The Schottky-Wagner model of non-stoichiometric compound phases, which was applied to predictions of phase stability by Kaufman and Clougherty, was used to predict the compositional and temperature dependences of metal and carbon vapor pressures over TiC, ZrC, HfC, NbC, and TaC. Comparison of predicted congruency behavior with available data yielded satisfactory results. (auth)

7454 STUDIES IN THE THORIUM–CARBON BINARY SYSTEM. S. Langer, N. Baldwin, P. Gantzel, F. Kester, C. Hancock (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 359-86 (1964).

Results of an investigation of the thorium-carbon system in the region from the monocarbide to about 80 mole % carbon are presented. The work was concentrated on the region in which ThC_2 and graphite are the equilibrium phases. The ThC_2–C eutectic temperature was confirmed as 2495 ± 40°C. Primary-phase ThC_2 was observed only rarely, indicating that the eutectic composition is close to that of the stoichiometric compound. The eutectic composition is estimated to be about 10 wt % C. The region of existence of the dicarbide extends from about 8 to 9.56 wt % carbon ($ThC_{2.04}$) in contrast to the normally substoichiometric UC_2. The solubility of carbon in ThC_2 appeared to decrease with increasing temperature. Thermal effects indicating the presence of two solid-state transitions separated by approximately 50°C were found at 1427 ± 21 and 1481 ± 28°C. Attempts to "quench-in" the high-temperature forms were unsuccessful. High-temperature x-ray studies showed that polymorphic transformations to a body-centered tetragonal and a face-centered cubic phase take place at the above temperatures. The possible space groups of these high-temperature phases are discussed. Metallographic examination of the dicarbide revealed a banded, martensitic-type structure similar to that observed in other materials that have undergone diffusionless transformations. X-ray and metallographic evidence indicated that a two-phase region exists between the monocarbide and dicarbide. This region extends from about 6.5 to 8 wt % carbon. It was not possible to firmly establish the construction of the phase diagram in this region; the data however, suggested a miscibility gap such as is present in the uranium–carbon system. X-ray lattice parameters of the monocarbide phase as a function of carbon content are given. A modified phase diagram is proposed. (auth)

7455 THE ELASTIC PROPERTIES OF URANIUM CARBIDE BETWEEN 4.2 AND 300°K. L. J. Graham and R. Chang (Atomics International, Canoga Park, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 409-22(1964).

The three elastic constants, C_{11}, C_{12}, and C_{44}, for uranium carbide were measured between 4.2 and 300°K. Between 4.2 and about 50°K, the elastic properties of UC fit the following expressions: $C_{11} = 3.296 \times 10^{12} (1 - 2.4 \times 10^{-7} T^2)$ dynes/cm², $(C_{11} - C_{12})/2 = 1.200 \times 10^{12} (1 - 3 \times 10^{-7} T^2)$ dynes/cm², and $C_{44} = 0.6430 \times 10^{12} (1 + 2.0 \times 10^{-6} T^2)$ dynes/cm². Both the T^2 dependence and the large temperature coefficients suggest a large electronic contribution from the displacement of the Fermi surface by elastic strain and a strong anisotropy of the shape of the Fermi surface. The Debye temperature evaluated at the absolute zero of temperature is $\theta_0 = 330.0$°K, compared with a value of 320 ± 10°K computed from the low temperature specific heat data of Combariеu and coworkers. (auth)

7456 PHYSICAL AND MECHANICAL PROPERTIES OF TRANSITION METAL DIBORIDES. Edward V. Clougherty and Richard L. Pober (ManLabs, Inc., Cambridge, Mass.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 423-43(1964).

Experimental data are presented for the temperature coefficients of linear expansion (25 to 1000°C), the temperature coefficients of electric resistivity (25 to 1000°C), and the variations of microhardness with indenter load, crystallographic orientation, and temperature (25 to 1000°C) for well-characterized materials. Specimens were prepared by floating-zone refining and by high-pressure hot pressing. The experiments were designed to provide property data characteristic of the pure diboride materials. The linear expansion data were obtained by the dilatometric technique. The results were compared with those obtained by other similar investigations by high-temperature x-ray procedures. Electric resistivity measurements were carried out with four independent molybdenum leads attached to the diboride specimen. The relatively low values of the room-temperature resistivity of dense high-purity specimens and the successful completion of measurements up to 1000°C provided data of a type not previously available for these materials. The hardness data are presented in terms of three variables: crystallographic orientation, indenter load, and temperature. Pronounced variation of hardness within large single grains of HfB_2 were observed for different orientations of the indenter relative to the surface of the grain. The measured variation of Knoop hardness numbers, H_K, with indenter load, P, can be described as $H_K = 1/AP$ where A is a constant. The high room-temperature hardness values of the diborides initially decreased rapidly with increasing temperature, but the data above 600°C suggested an apparent anomaly, which will require additional study. In addition, literature information on the measured properties and on thermal conductivity, modulus, and strength are discussed. The general problems of thermal shock are reviewed and procedures for reducing this property are suggested. (auth)

7457 PROPERTIES OF URANIUM MONOPHOSPHIDE, URANIUM MONOSULFIDE AND UP–US SOLID SOLUTIONS. Y. Baskin and P. D. Shalek (Argonne National Lab., Ill.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 457-61(1964).

Information on the properties of UP, US, and UP–US solid solutions are reviewed. Methods of preparation of the two compounds are described. Data are presented on the following properties: lattice parameters, microhardness, electric resistivity, melting point, thermal conductivity, thermal expansion, vaporization behavior, oxidation behavior, compatibility, and sintering characteristics. (auth)

7458 CORROSION AND OXIDATION CHARACTERISTICS OF URANIUM MONONITRIDE. Josef Bugl and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 463-75(1964).

The oxidation kinetics of UN in CO_2, oxygen, and water-saturated air were found to obey the linear weight-gain law with activation energies ranging from 10,400 to 15,400 cal/mole. The oxidation product at temperatures of 300°C and greater was U_3O_8. UN corroded in 300°C water to form UO_2 but the rate of corrosion was highly sensitive to stoichiometry and to density, with cast, 100% dense, stoichiometric UN exhibiting optimum corrosion resistance as compared with non-stoichiometric UN prepared either by casting or by powder metallurgical techniques. Corrosion rates in 100°C water, 350°C Santowax R, and 820°C NaK were small or negligible. (auth)

7459 STUDIES ON THE VAPOR PRESSURE AND OXIDATION OF CERTAIN BERYLLIDES. J. Booker, R. M. Paine, A. J. Stonehouse (Brush Beryllium Co., Cleveland). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 477-93(1964).

The decomposition pressure of the beryllides $TaBe_{12}$, Ta_2Be_{17}, $ZrBe_{13}$, and Zr_2Br_{17} were determined by the Knudsen cell technique in the temperature range 1533 to 1728°K. The rates of oxidation of these beryllides were determined from 1533 to 1783°K. The continuous recording of weight changes that occurred, under the appropriate atmosphere, was employed as the means of obtaining the experimental data for both measurements. The results of these measurements are discussed. X-ray diffraction data were used to identify the reaction products for both measurements. Decomposition products from vaporization were a lower beryllide and beryllium. Decomposition products from oxidation were a lower beryllide and BeO. Because of variable behavior of some of the compounds over the observed temperature range, reaction energies of the oxidation and vaporization processes could not be directly compared in all cases. However, where reaction energies could be determined from temperature-rate relationships, it was indicated that different rate-determining steps were operative for the two processes. The rate-determining process was found to be temperature dependent in each case. (auth)

7460 THE PREPARATION OF MIXED Pu–U CARBIDES BY THE METAL–HYDROCARBON GAS REACTION.

F. Brown, P. T. Good, and R. Lapage. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 513-24(1964).

Mixed plutonium-uranium carbide (15Pu-85U) powders were prepared by the reaction of finely divided metal with propane in the temperature range 645 to 745°C. The reaction rate was studied using a thermobalance. A possible kinetic scheme is discussed and compared with date obtained on uranium carbide. The carbide powders were pressed and sintered to provide information on x-ray parameters. The effect of nitrogen impurity in the lattice parameter of Pu-U and Pu monocarbide was determined. (auth)

7461 ZONE REFINING AND STOICHIOMETRY CONTROL OF URANIUM CARBIDE. H. Nadler and R. Chang (North American Aviation Science Center, Canoga Park, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 525-38(1964).

A two-step process for the preparation of high-purity stoichiometric uranium carbide single crystals by means of electron beam float-zone melting and hydrogen reduction of the float-zone-melted product is described in detail. Additional methods to improve the purity and perfection of the material are suggested. (auth)

7462 THERMOCHEMICAL PREPARATION AND PROPERTIES OF CARBIDES FOR NUCLEAR APPLICATIONS. R. L. Heestand, J. I. Federer, C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). Met. Soc. Am. Inst. Mining. Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 539-45(1964).

Thermochemical deposition was investigated as an approach to the preparation and fabrication of high-quality metal carbides. Deposition parameters of boron carbide and silicon carbide were studied in the interest of fabricating free-standing shapes or as coatings for high-temperature nuclear applications. In general these carbides were produced under reduced pressure (10 to 100 μ) by the hydrogen reduction of metal halides in the presence of a hydrocarbon. Deposition parameters and their effect on composition and deposition rate are presented. The composition of boron carbide could be continuously changed through the thickness of the deposit by varying the temperature or the gas ratios. Thermochemical deposits of boron carbide and silicon carbide were evaluated by metallography, chemistry, and x-ray analysis as a function of deposition parameters. These evaluations showed that material of high purity, having fine grain and random orientation, could be obtained by this process. The carbides produced in various shapes in this manner possessed high strength and approached theoretical density. Hardness of stoichiometric compositions often exceeded those of commercial material. (auth)

7463 PREPARATION AND PROPERTIES OF LANTHANON MOLYBDATES AND TUNGSTATES. R. A. Potter, R. E. McDonald, and C. F. Leitten, Jr. (Oak Ridge National Lab., Tenn.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 547-56(1964).

Stainless steel-clad dispersions of Eu_2O_3 were successfully used for reactivity control in pressurized-water power reactors. However, a major objection to their usage is the poor hydration resistance of the oxide. Additions of 15 wt % MoO_3 or WO_3 to Eu_2O_3 were found to stabilize the europium oxide against hydration in pressurized water. Investigation of the mechanisms involved disclosed the formation of a single-phase compound, which possessed a face-centered cubic structure closely related to the normal body-centered cubic form of Eu_2O_3. Several methods of preparing the material were investigated and the feasibility of synthesis by arc fusion was established. It was demonstrated that europium molybdate could be produced in large quantities by arc fusion with good compositional control and high material yields. Data concerning the compatibility of the compound with type 304 stainless steel and also the elemental constituents Fe, Si, Ni, and Cr were obtained. These tests were conducted in H_2, Ar, and vacuum atmospheres in the temperature range 1100 to 1250°C. The compatibility of europium molybdate with these materials appeared similar to that of Eu_2O_3. The compound was observed to react with silicon and silicon-bearing stainless steel. The compound was stable in stainless steel of silicon content <0.03% synthesized from the elemental constituents. Europium molybdate was unstable in hydrogen and dissociated to Eu_2O_3 and molybdenum metal. This dissociation did not occur in an inert atmosphere. The results of these compatibility studies in conjunction with the aqueous corrosion data indicated that europium molybdate has potential nuclear applications. During the course of this investigation, it was also determined that the lanthanon oxides Sm_2O_3, Gd_2O_3, and Dy_2O_3 react with MoO_3 or WO_3 to form similar hydration-resistant face-centered cubic compounds. (auth)

7464 CHARACTERIZATION AND PROPERTIES OF ARC-MELTED URANIUM MONONITRIDE. R. W. Endebrock, E. L. Foster, and D. L. Keller (Battelle Memorial Inst., Columbus, Ohio). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 557-563(1964).

Uranium mononitride, both as polycrystalline material and as large single crystals, can be prepared by consumable-electrode arc-melting procedures. The methods are described. UN single crystals showed an average Knoop hardness of 555 and a Vicker's hardness of 500. Densities obtained by the displacement technique varied from 99 to 100.1% of theoretical. Congruent melting occurred at 2850 ± 50°C at and above 2.5 atm nitrogen. An initial film of oxide, which formed on crystal surfaces offered protection from further oxidation. Some information regarding UN structure as determined from single crystals of UN is also presented. (auth)

7465 NITROGEN CONCENTRATIONS IN URANIUM CARBO–NITRIDES MELTED UNDER ONE-THIRD ATMOSPHERE OF NITROGEN. W. Chubb and D. L. Keller (Battelle Memorial Inst., Columbus, Ohio). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 565-71(1964).

Systems of uranium containing 1 to 5 wt % carbon were arc melted under a partial pressure of $\frac{1}{3}$ atmosphere of nitrogen. Analyses of the products showed that the amount of nitrogen absorbed decreases as the carbon content increases. This relationship continued beyond the point at which all free uranium is consumed to form uranium monocarbo-nitride, U(C,N). When melting under a partial pressure of $\frac{1}{3}$ atmosphere of nitrogen, only one initial carbon content will result in stoichiometric U(C,N). (auth)

7466 PREPARATION OF URANIUM MONOCARBIDE FROM U_3O_8. E. W. Murbach and S. Strausberg (Atomics International, Canoga Park, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 573-8(1964).

Preparation of uranium monocarbide of controlled composition from U_3O_8 is of interest in one of the pyrometallurgical reprocessing methods being developed. The first step is oxidation of the UC fuel in air or oxygen, producing U_3O_8. Direct carbothermic reduction of U_3O_8 eliminates hydrogen reduction of U_3O_8 to UO_2. In the direct carbothermic reduction process, U_3O_8 and carbon are mixed in a one to ten mole ratio and heated in vacuum to approximately 900°C until gas evolution ceases. During this step, the U_3O_8 is reduced to UO_2 with CO_2 as the product. The remaining UO_2 and carbon in a mole ratio of one to three are reacted in vacuum at elevated temperatures to yield the carbide. The low-temperature step was studied by measuring the rate of weight loss on a thermobalance and by collecting the evolved CO_2 in a liquid nitrogen trap and subsequent expansion into a known volume. An activation energy of approximately 42 kcal was determined for the low-temperature reaction. The high-temperature step proceeds at a greater rate at a given temperature than that observed with a starting mixture of UO_2 and carbon. Reaction rates were correlated by a $\frac{3}{2}$ order rate equation and the resultant rates gave an activation energy of approximately 71 kcal. Preparations of UC by this method were carried out up to the kilogram scale with final carbon content $< \pm 0.01$ wt % C of the calculated amount. (auth)

7467 DEBYE TEMPERATURES AND THERMAL PROPERTIES OF HfB_2, ZrB_2, HfC AND ZrC FROM X-RAY

DIFFRACTION MEASUREMENTS. Harold Bernstein (Man-Labs, Inc., Cambridge, Mass.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 609-25(1964).

The thermal vibrational behavior of the refractory compounds HfB_2, ZrB_2, HfC, and ZrC was examined with high temperature x-ray techniques. Debye temperature parameters were calculated from the x-ray data on the basis of both an artificial monatomic solid (average θ method), and an individual atom model with equal thermal amplitudes (two θ method). The vibrational anisotropy of the hexagonal diborides was taken into account. Room temperature entropies calculated on the basis of the "two θ" model with appropriate averaging over vibrational anisotropy agreed with experimental entropies to within about 15%. Room temperature lattice constants and thermal expansion coefficients in the range 800 to 1500°C for these compounds and some other borides are reported. (auth)

7468 MICROSTRUCTURES OF U–C ALLOYS. Shuichiro Takahashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Saitama, Japan), Bumpei Ishii, Kazuo Yamamoto, Hajime Uchikoshi, and Yumi Akimoto. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 627-40(1964).

Microstructures of both slow-cooled and quenched U–C alloys having carbon contents in the range between UC and UC_2 were studied. Electron microscopy in combination with optical microscopy was found to be beneficial in acquiring several experimental results, which are discussed from the viewpoints of nucleation and growth mechanism and relative orientation of precipitate and matrix. Relative resistance to two chemical etchants was determined for the UC, U_2C_3 and UC_2 phases. (auth)

7469 PULSE-HEATING OF ZIRCONIUM–URANIUM HYDRIDE. R. E. Taylor (Atomics International, Canoga Park, Calif.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 641-50(1964).

Samples of zirconium uranium hydride were pulse-heated to destruction within 500 milliseconds. The rate of power input, temperature history rate of hydrogen evolution, and electric resistivity were measured during the transients and the samples were observed using high-speed photography. Although many samples failed due to non-uniform heating, about half of the samples remained intact until most or all of the hydrogen was evolved. During the first 150 milliseconds of the pulse, all of the power input was consumed by raising the sample temperature at a rate of 5000°C per second. However as hydrogen began to evolve, the rate of temperature rise fell off towards a constant value and the major portion of the heat input was consumed by the heat of dissociation of zirconium hydride. From these data, the specific heat of $ZrU_{0.04}H_{1.7}$ was determined from room temperature to 900°C, the presence and composition of the phase change ($ZrH_{1.40}$) was noted, and the heat of dissociation of $ZrU_{0.04}H_{1.40}$ (49.2 ± 2.0 kcal/mole of H_2) was calculated. (auth)

7470 A REVIEW OF METAL–HYDROGEN SYSTEMS FOR NUCLEAR APPLICATIONS. William M. Mueller (Univ. of Denver). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 679-701(1964).

Criteria applied to materials for use in reactors and pertinent research devoted to metal hydrides as potential reactor materials are reviewed. A number of metal-hydrogen systems including those of zirconium, yttrium, titanium, the lanthanides, and the actinides were studied along with certain alloy-hydrogen systems. The results of these studies in terms of equilibrium relationships are also reviewed. An evaluation of the present knowledge of metal hydrides and a recommendation for the direction of future studies are made. (auth)

7471 IONIZATION OF MERCURY BY ALKALI POSITIVE IONS. Rafi Mohammed Chaudhri, Hamid Ahmad Khan, Khan A. Shoaib, and M. Munawar Chaudhri (High Tension and Nuclear Research Lab., Lahore). Nature, 204: 987-8 (Dec. 5, 1964).

The radiation resulting from ionization of mercury by potassium ions was investigated using a quartz photoelectron multiplier. The photomultiplier pulses were fed through a cathode follower to a high-gain amplifier the output of which was read in a scaler. It was observed that the radiation is first emitted at an energy as low as 60v. Its intensity increased gradually with ion energy but there was an abrupt increase at 89 to 90v. The rise in the intensity of the radiation was rapid above this energy. (M.C.G.)

7472 VISIBLE AND INFRARED ABSORPTION SPECTRA OF URANIUM DIOXIDE. J. L. Bates (General Electric Co., Richland, Wash.). Nucl. Sci. Eng., 21: 26-9(Jan. 1965).

The absorption spectra for monocrystalline and polycrystalline UO_2 were measured between 0.6 and 15 μm at room temperature. The spectrum for UO_2 resembles that of a typical semiconductor–opaque in the visible, but transparent over a large portion of the infrared. An absorption edge is located at approximately 0.6 μm (2.0 ev). A large optical window extends from 3 to 13 μm. The absorption coefficient for monocrystalline UO_2 was determined between 1.5 and 15 μm. A maximum value of 57 cm^{-1} was measured at 1.70 μm with minimum values of 6 cm^{-1} at 2.75 and 8 μm. The absorption coefficient of polycrystalline UO_2 at wavelengths less than 8 μm is estimated to be ten times larger than for monocrystalline UO_2. (auth)

7473 LAMELLAR COMPOUNDS OF GRAPHITE WITH NITROGEN PENTOXIDE AS POSSIBLE REACTOR HAZARDS. Gerhart Hennig (Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 34-9(Jan. 1965).

Two different reactions were found to occur simultaneously when graphite is exposed to air which was ozonized by a high-voltage silent discharge. One is the formation of a lamellar compound with nitrogen pentoxide which is always present in ozonized air. The second reaction is a rapid volatilization because of oxidation, which has also been traced to nitrogen pentoxide rather than to the much less reactive ozone. The lamellar compound was characterized as an acceptor-type compound in which every two molecules of pentoxide constitute one electron acceptor. Equilbrium concentrations which are established in a few hours in ozonized air amount to about 10 wt % of pentoxide at 25°C, and 0.1 wt % at 150°C. The oxidation reaction was studied both in ozonized air and in N_2O_5. A much slower oxidation occurs in ozonized oxygen which can, however, be considerably accelerated if the graphite is first converted to a lamellar N_2O_5 compound. Pre-irradiation of the graphite causes only minor changes in the rates of compound formation and oxidation. The reactions may constitute hazards to reactors operating at low temperatures. (auth)

7474 SOME COMMENTS ON THE DIFFUSIVE MOTION AND NUCLEAR SPIN-LATTICE RELAXATION IN WATER. D. P. Tewari and G. S. Verma (Univ. of Allahabad, India). Nuovo Cimento (10), 34: 1638-43(Dec. 16, 1964).

The basic ideas of the jump diffusion model are applied to nuclear spin-lattice relaxation in water and information regarding the influence of temperature on the nature of diffusive motion in water was obtained. The number of solidlike vibratory modes initially decreases rapidly as the temperature is increased from 0°C and at about 40°C it drops to a value which remains constant up to 92°C. At room temperature about 30% of the modes are Langevin type and the rest solidlike. As much as 50% of the modes of vibration are still solidlike near the boiling point. By assuming that the time τ_0 during which a molecule stays at a site and performs complicated vibratory motion is the shear relaxation time, values of shear modulus in water at different temperatures and pressures are obtained. (auth)

7475 ION-ION RECOMBINATION IN LABORATORY AIR. S. McGowan (Defence Chemical Biological and Radiation Labs., Ottawa). Phys. Med. Biol., 10: 25-40(1965).

The ion-ion recombination rate in laboratory air at atmospheric pressure and room temperature was re-investigated experimentally. Both pulsed and continuous irradiation methods were used. The pulsed source enabled the recombination coefficient to be measured as a function of ion age between ½ msec and ½ sec. It is shown that the

very high initial recombination rates at low ion ages can be satisfactorily explained by the existence of microscopic regions in which the ion density is much higher than the average density over the ionized volume. Decreases in the recombination coefficient that were observed in a few cases at about 50 msec ion age were attributed to changes in the type of ions involved. Day-to-day variations in the recombination coefficient were ascribed to variations in the minor constituents of the air used. The results of pulsed and continuous methods for recombination coefficient are in quantitative agreement yielding a value of 1.4×10^{-6} cm^3 sec^{-1} for untreated laboratory air. Although the air used was not necessarily representative of other laboratory environments, this value shows that for much practical work a recombination coefficient considerably lower than that reported in the literature for carefully dried air should be used. (auth)

7476 MOBILITIES AND REACTION RATES OF IONS IN HELIUM. E. C. Beaty and P. L. Patterson (Univ. of Colorado, Boulder). Phys. Rev., 137: A346-57(Jan. 18, 1965).

The mobility of He^+ ions in helium gas was measured to be 10.40 ± 0.10 (cm^2/V-sec). The He^+ ions were observed to react with the helium gas, the attachment frequency being $[1.08 \pm 0.05] \times 10^{-31}$ $n^2(sec^{-1})$, where n is the gas density in atoms/cm^3. This value of the attachment frequency is roughly compatible with the theoretical estimate of Bates and with the mass-spectrometric measurement of Phelps and Brown for the rate of the three-body attachment reaction producing He_2^+. The mobility of the product ion, He_2^+, was found to be 16.70 ± 0.17. This mobility is compatible with recent ambipolar diffusion coefficient measurements on cold afterglows, where the identification of the ion is confirmed by the spectroscopic observations of Kerr. This mobility is inconsistent with the widely quoted value of Biondi and Chanin and with the theoretical analyses of Geltman and Dalgarno. Mobility determinations were also made on another ion, which is possibly what Biondi and Chanin called He_2^+. The actual identity is unknown, the ion possibly being He^{3+}, possibly a contaminant. (auth)

7477 OPTICAL ABSORPTION SPECTRA OF ALKALI ATOMS IN RARE-GAS MATRICES. W. Weyhmann and F. M. Pipkin (Harvard Univ., Cambridge, Mass.). Phys. Rev., 137: A490-6(Jan. 18, 1965).

Studies of the optical absorption spectra of alkali-doped rare-gas crystals are reported. The samples were formed by deposition from a mixed beam of the two constituents onto a cold plate. Eight combinations of Na, K, Rb, and Cs in Ar, Kr, and Xe were studied. In each case the spectrum consisted of two triplets, one of which was centered at approximately the free-atom value and one of which was shifted to the blue by roughly 1400 to 1800 cm^{-1}. The relative intensity of the two triplets could be changed by varying the deposition conditions; the unshifted triplet became dominant when the sample was deposited directly on a helium-filled Pyrex tube. The interval between the three components of the unshifted triplet was roughly the same for all combinations of alkali-metal atom and rare-gas matrix. In order to understand the nature of the site, a configuration coordinate scheme was invoked to deal with the energy shifts and the linewidths, and a crystalline-field approach was employed to explain the level splittings. The first analysis indicates that the sites are not substitutional and the second that the splitting can be understood in terms of a lattice distortion which is the same in all cases. (auth)

7478 PARAMAGNETIC RESONANCE ABSORPTION IN AN OPTICALLY EXCITED STATE IN CaF_2:Dy^{2+}. E. S. Sabisky and C. H. Anderson (RCA Labs., Princeton, N. J.). Phys. Rev. Letters, 13: 754-6(Dec. 21, 1964).

Paramagnetic resonance absorption was observed in a metastable state of CaF_2:Dy^{2+} populated by optical pumping. Measurements of the linewidth, relaxation time, fluorescence lifetime, and linear |g| value are reported. (C.E.S.)

7479 OPERATION OF A PROTON-SPIN REFRIGERATOR. K. H. Langley and C. D. Jeffries (Univ. of California, Berkeley). Phys. Rev. Letters, 13: 808-9(Dec. 28, 1964).

A polarization p = 10.5% for the protons in a crystal of yttrium ethyl sulfate was obtained by rotating the crystal in a magnetic field in a liquid helium bath. Approximately 2% of the yttrium is replaced by paramagnetic Yb^{3+} ions, which behave like electron spins with a very anisotropic g factor. In this solid-state spin refrigerator the Yb^{3+} spins act as a working substance cyclically transferring heat from the protons to the bath via the crystal-lattice phonons. (C.E.S.)

7480 LUMINESCENCE OF QUENCHED ZnS:Cu PHOSPHORS. Z. Švec and J. Mravinac (Research Inst. for Vacuum Electrotechnics, Prague). Phys. Status Solidi, 7: K161-2(1964).

The effect of quenching on the properties of ZnS:Cu phosphors was investigated. The quenched phosphors were heated at 100 to 300°C for ½ to 40 hr. During the annealing strong changes in the color of the emission were observed. The color of the luminescence changed from green to yellow and red, the emission disappeared, and, finally, green luminescence appeared whose intensity was higher than that of the initial green luminescence. It is suggested that the high-temperature equilibrium of the system ZnS:Cu frozen-in by quenching is characterized by the usual green luminescence. The conversion to low-temperature equilibrium during the annealing proceeds in two stages accompanied by an increase in the concentration of red and killer centers and by precipitation of Cu on the surface and within the crystal. (C.E.S.)

7481 EFFECTS OF DEFORMATION ON THE INTENSITY OF A NUCLEAR MAGNETIC RESONANCE SIGNAL. O. Kanert (Universität, Münster, Ger.). Phys. Status Solidi, 7: 791-803(1964). (In German)

Measurements are made of the nuclear magnetic resonance in alkali halide crystals ($^{23}Na^{35}Cl$, $^{23}Na^{19}F$, $K^{79}Br$, $K^{81}Br$, and $K^{127}I$). The integral intensity of the signal decreases with increasing degree of plastic deformation (i.e., with increasing dislocation density). This decrease which is found for nuclear spin $I > ½$ is believed to be due to an interaction between the quadrupole moment and the field gradient caused by the lattice distortion. By assuming a random distribution of dislocations, an expression is derived for the dependence of the signal intensity on the dislocation density. The NMR values for the dislocation density are found to coincide with the results of etching experiments, and to be in agreement with theory. This method is also used to determine the dependence of the dislocation density on the degree of plastic deformation for the substances. (auth)

7482 COLOR CENTERS IN ADDITIVELY COLORED CaF_2 AND BaF_2. J. Arends (Universiteit, Groningen, Netherlands). Phys. Status Solidi, 7: 805-15(1964).

The electron spin resonance method is applied to the study of the structure of color centers in additively colored CaF_2 and BaF_2 crystals. Together with optical absorption measurements and bleaching experiments the results indicate that the α-band in CaF_2 and the 6600 Å band in BaF_2 are due to an electron trapped in an F^- vacancy. The hyperfine interactions between the unpaired electron and the surrounding nuclei are discussed and compared with the results obtained for F-centers in alkali fluoride crystals. The optical bleaching experiments lead to probable models for other absorption bands in CaF_2. (auth)

7483 STRUCTURE OF THE SPECTRA OF DISORDERED SYSTEMS. III. MATSUDA'S THEOREM ON SPECIAL FREQUENCIES. Jun-ichi Hori (Hokkaido Univ., Sapporo). Progr. Theoret. Phys (Kyoto), 32: 471-7(Oct. 1964).

It is shown that Matsuda's theorem on special frequencies in the vibrational frequency spectrum of isotopically disordered diatomic chain is just a special case of Theorem IV previously presented. The physical content of the theorem is clarified, and an expression that gives the critical mass ratio for every special frequency is derived. From this one can obtain the distribution of special frequencies for any given mass ratio. It is shown further that the theorem can easily be generalized to the case of polyatomic chain. (auth)

7484 STUDY ON THE REACTIVITY OF ADSORBED HYDROGEN BY MEANS OF TRITIUM AS TRACER. Daisaku Miyatani and Toyosaburo Takeuchi (Toyama Univ., Japan). Radioisotopes (Tokyo), 13: 439-43(Nov. 1964). (In Japanese)

The relation between the bond strength of adsorbed hydrogen and the reactivity of the hydrogen for ethylene was investigated by using tritium as tracer. Hydrogen (or tritium) was adsorbed first on a powdered nickel at −78°C and tritium (or hydrogen) was subsequently adsorbed, then ethylene was added. The adsorption of hydrogen was made by changing the coverage, i.e., 0.08 and 0.2 for the nickel reduced at 200°C, and 0.03 and 0.2 for the nickel reduced at 400°C. After a certain time, hydrogen and the mixture of ethane and ethylene were drawn off from the reaction vessel and separated. The assay of tritium in each fraction of gas was then made. The result on the nickel reduced at 200°C indicated that neither the hydrogen very strongly adsorbed nor that weakly adsorbed reacts with ethylene. The result on the nickel reduced at 400°C indicated that the hydrogen weakly adsorbed does not react with ethylene. These results suggest that the very strong sites for the adsorption of hydrogen, which are inactive for the hydrogenation reaction would diminish by the elevation of the reduction temperature. (auth)

7485 ENERGY DIAGRAMS OF Ho^{+3}, Tb^{+3}, AND Tm^{+3} IONS IN CUBIC POTENTIALS AND EXCHANGE FIELD. Yoshio Ebina and Noboru Tsuya. Sci. Rept. Res. Inst., Tohoku Univ., Ser. B, 15: Suppl., 1-46(1963).

The electronic structures in heavy rare earth trivalent ions Ho^{+3}, Tb^{+3}, and Tm^{+3} without Kramers degeneracy were examined theoretically. The kinds of fields acting on 4f electrons in these ions were taken into consideration. The effective exchange field, which is parallel in direction to ⟨100⟩ and ⟨111⟩, and both the fourth and sixth order cubic crystalline fields were considered. Solving the equations for the Hamiltonian with the aid of electronic computer, the energy levels and the corresponding eigenvectors, as well as the mean values $\langle M_J \rangle$ of the z component of the total angular momentum of these rare earth ions were tabulated. The triangular diagrams expressing the equi-$\langle M_J \rangle$ contour lines are illustrated. In these calculations, thirty-six cases were selected, which corresponded to thirty-six combinations of two sorts of parameters k and u, the former, k, expressing the mixing degree of the sixth order potential and the latter, (1-u), that of the exchange energy in the Hamiltonian. Application of the results obtained is explained by some examples. (auth)

7486 ENERGY DIAGRAMS OF Dy^{+3}, Er^{+3}, AND Yb^{+3} IONS IN CUBIC POTENTIALS AND EXCHANGE FIELD. Yoshio Ebina. Sci. Rept. Res. Inst., Tohoku Univ., Ser. B, 15: Suppl., 47-85(1963).

Electronic structures in heavy rare earth trivalent ions Dy^{+3}, Er^{+3}, and Yb^{+3} with Kramers degeneracy were examined theoretically. Three sorts of fields act on 4f electrons in these ions: the effective exchange field, which is parallel in direction to ⟨100⟩ or ⟨111⟩ and the fourth and sixth order cubic crystalline fields. After solving the equations for the Hamiltonian with the aid of electronic computer, the energy levels, the corresponding eigenvectors, and the mean values $\langle M_J \rangle$ of the z component of the total angular momentum of these rare earth ions were tabulated. The triangular diagrams expressing the equi-$\langle M_J \rangle$ contour lines are illustrated. In these calculations, thirty-six cases were selected, which corresponded to thirty-six combinations of two sorts of parameters k and u, with k expressing the mixing degree of the sixth order potential and (1-u) that of the exchange energy in the Hamiltonian. Some examples in the use of the results are given. (auth)

7487 INVESTIGATION OF THE $NaF-Na_2BeF_4-Na_3ZrF_7$ SYSTEM. Ngok-mai Chang and A. V. Novoselova. Vestn. Mosk. Univ., Ser. II, Khim., No. 3, 37-9(May-June 1964). (In Russian)

Visual polythermal and diffusion studies were made on the $NaF-Na_2BeF_4-Na_3ZrF_7$ system. From the three binary systems that made up the ternary system the phase diagram and liquidus areas were constructed. At 220 and 330°C polymorphic conversions of Na_2BeF_4 were observed, and 545°C was the melting point of the ternary eutectic. (IIC-M.G.)

7488 SPACE GROUP SELECTION RULES. Hsi-teh Hsieh and Hsiao-shen Chen (Fu Tan Univ., Shanghai). Wu Li Hsueh Pao, 20: 970-90(Oct. 1964). (In Chinese)

Based on the general methods for the reduction of direct product of space group irreducible representations developed by Birman, a simpler method of finding the wave vector selection rules is derived. The method is applied to the hexagonal close-packed and the wurtzite space groups. The coupling coefficients for the reduction of the direct products of two space group irreducible representations are given explicitly. (auth)

7489 AN X-RAY-DIFFRACTION STUDY OF TETRAGONAL US_2. Rose C. L. Mooney Slater (Massachusetts Inst. of Tech., Cambridge). Z. Krist., 120: 278-85(Aug. 1964).

The crystal structure of tetragonal US_2 was derived from powder and some single crystal data. The cell dimensions, measured with $CuK\alpha_1$, wavelength 1.540 Å, are $a = b = 10.28 \pm 0.01$ Å, $c = 6.327 \pm 0.005$ Å. On the assumption that there are 10 US_2 per unit cell, the calculated density is 7.50 g/cm³. The proposed structure has the symmetry of $I4/mcm(D_{4h}^{18})$, with all of the atoms in special positions. This may be an idealization, because only small displacements of the atoms in the c-axial direction are necessary to reduce the symmetry to $I4cm(C_{4v}^{10})$ or $I\bar{4}c2(D_{2d}^{12})$. The two geometrically different uranium atoms in the structure have different environments. Of the ten uranium atoms in the unit cell, eight have a coordination of six sulfur atoms, with uranium to sulfur distances of 2.77 Å. The remaining two, which are statistically distributed in fourfold positions, have a coordination of eight, with uranium to sulfur distances of 2.81 Å. The structure type is different, and has no obvious relation to orthorhombic US_2, which, like ThS_2, has the $PbCl_2$ structure. (auth)

7490 TERNARY OXIDES OF INDIUM, YTTRIUM, AND RARE EARTHS WITH THE ALKALINE EARTH METALS CALCIUM, STRONTIUM, AND BARIUM. Hermann Schwarz and Dieter Bommert (Technische Hochschule, Karlsruhe, Ger.). Z. Naturforsch., 19b: 955-6 (Oct. 1964). (In German)

Investigations of systems of SrO, BaO, or CaO with rare earth oxides are summarized. The lattice constants are listed. (M.C.G.)

7491 CATALYTIC DECOMPOSITION OF TRITIUM-LABELED COMPOUNDS IN CLOSED TUBES. H. Koch and J. Dermietzel (Institut für Angewandte Radioaktivität, Leipzig). Z. Naturforsch., 19b: 960-1(Oct. 1964). (In German)

Catalytic decomposition of tritium-labeled organic compounds was studied in the presence of water and zinc. The effectiveness of the catalysts increased in the following order: V_2O_5; Mg; Cu; NiO; PbO; $Fe(OH)_3$; WO_3; Zn; Fe_2O_3; Co_3O_4; MoO_3; Al; CoOOH; MnO_2; Fe; Raney Ni; and CoOOH/V_2O_5. It was concluded that oxygen-containing substances are not necessary for decomposition of tritium-labeled compounds in a closed tube and that oxygen content or oxygen yield is not a measure of the quality and effectiveness of the catalyst. (M.C.G.)

7492 HYDROLYSIS OF UO_2^{++} IN DILUTE SOLUTIONS. Milos Bartusek and Lumir Sommer (Univ. of Brno). Z. Physik. Chem. (Leipzig), 226: 309-32(1964). (In German)

The hydrolysis of dilute uranyl perchlorate and uranyl nitrate solutions with $c_M = 2 \times 10^{-4} - 4 \times 10^{-3}$ mole/l in water and water–ethanol mixtures was studied using spectrophotometric and potentiometric methods. The results were compared with those to be found in the literature. In the solutions used the formation of only two complexes, $[UO_2(OH)_2UO_2]^{2+}$ and $[UO_2(OH)UO_2)^{3+}$, was confirmed. Their equilibrium constants and molar extinction coefficients were calculated. (auth)

7493 PRECISION OF ADSORPTION MEASUREMENTS. E. Herczynska (Inst. of Nuclear Research, Warsaw). Z. Physik. Chem. (Leipzig), 226: 411-14(1964).

Results of measurements of the adsorption of ^{137}Cs, ^{59}Fe, ^{60}Co, ^{131}I, and ^{32}P from aqueous solutions of pH 3 to 7 on Cu, Al, stainless steel, and glass surfaces are reported. The adsorption was performed by the drop method. $\sigma/\bar{x}$ is illustrated as a function of $\bar{x}$ (σ = standard deviation, $\bar{x}$ = average value of the measured activity in cpm) for the precision of: the radiometric procedure; the drop measurement (measurement of the total activity of 0.1 ml active solution); and the adsorption experiments. It was concluded that the drop method of adsorption is sufficiently precise; for most ions studied (cations in acid solutions and anions in neutral solutions) it attains for $\bar{x} \geq 1000$ cpm a precision of $\pm 6\%$ for n = 5 and $\pm 2.5\%$ for n = 20. (P.C.H.)

7494 STUDIES OF THE $UO_2SO_4-S-H_2O-(SiO_2)$ SYSTEM AT HIGH TEMPERATURES AND PRESSURES. A. D. Vlasov and R. P. Rafal'skii. Zh. Neorgan. Khim., 9: 2222-30(Sept. 1964). (In Russian)

Studies were made, in a quartz ampoule, of hexavalent uranium equilibrium concentration as a function of temperature and initial concentration in the system. Uranium concentrations drop sharply at 100 to 200°C and smoothly at temperatures over 200°C. The equilibrium content of uranium increased with the increase of the initial concentration. Uranium concentrations in the $H_2SO_4-UO_2-S-H_2O$ system at 200°C are similar to the respective equilibrium concentration in $UO_2SO_4-S-H_2O$ (at an equal molarity of H_2SO_4 and UO_2SO_4). Equations for reactions in the $UO_2SO_4-S-H_2O$ system at 100, 150, and 200°C were developed. (R.V.J.)

7495 MAGNESIUM THERMAL REDUCTION OF SCANDIUM FLUORIDE. L. N. Komissarova and B. I. Pokrovskii (Moscow State Univ.). Zh. Neorgan. Khim., 9: 2277-9(Oct. 1964). (In Russian)

Thermal and x-ray analyses of the Mg–Sc (to 40% Sc) constitution diagram showed that the system is peritectic with a transition point as 29 to 30 wt % Sc at 706°C. Magnesium at the solidus temperature dissolves 29 to 30 wt % Sc, in a melt the maximum scandum dissolution is 20 to 21 wt %. Magnetothermal reduction of scandium fluoride begins at 650°C. Up to 1000°C the reaction is shifted toward scandium formation. (R.V.J.)

7496 LANTHANUM PYRO-PHOSPHATES. I. V. Tananaev and V. P. Vasil'eva. Zh. Neorgan. Khim., 9: 2284-6(Oct. 1964). (In Russian)

Investigations of solubility, pH, specific conductivity, isomolar series, and solid phases in the $La(NO_3)_3-Me_4P_2O_7-H_2O$ system showed that La^{3+} reactions with $P_2O_7^{4-}$ form the low-solubility basic lanthanum pyrophosphate, $La_4(P_2O_7)_3 \cdot La(OH)_3 \cdot 12H_2O$. Thermographic and x-ray analyses were made of the prepared compound. (R.V.J.)

7497 ON THE SECOND STABILITY OF LITHIUM METAZIRCONATE MODIFICATION. S. A. Kutolin, N. A. Druz, and A. I. Vulikh. Zh. Neorgan. Khim., 9: 2359-61 (Oct. 1964). (In Russian)

A second metastable modification of lithium metazirconate (Li_2ZrO_3 II) was found in the Li_2O-ZrO_2 system. Kinetics of hydrolysis of both metazirconate modifications were investigated and their physico-chemical properties were determined. (R.V.J.)

7498 RARE EARTH METABORATES. G. I. Vasil'ev and V. V. Serebrennikov. Zh. Neorgan. Khim., 9: 2490-2 (Oct. 1964). (In Russian)

Precipitation of Y, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er, and Yb metaborates in $Ln(BO_2)_3 \cdot nH_2O$ was studied. The composition of metaborates dried at 60°C was $Ln(BO_2)_3 \cdot 6H_2O$; for metaborates dried at 80°C, $Ln(BO_2)_3 \cdot 4H_2O$. The solubility of metaborates in water diminished from lanthanum to gadolinium and then increased from gadolinium to the end of lanthanide series. (R.V.J.)

7499 ON THE PROPERTIES OF $UO_{2.9}$. V. N. Strekalovskii, A. R. Beketov, and V. G. Vlasov. Zh. Neorgan. Khim., 9: 2496(Oct. 1964). (In Russian)

Vacuum pycnometry was used for measuring the density of specimens prepared by dissociation of α- and γ-uranium trioxide of $UO_3-U_3O_8$ composition. An x-ray analysis revealed a finite dissociation product of mixed uranium oxide with orthorhombic structure. (R.V.J.)

7500 SOLUBILITY OF DIVALENT EUROPIUM SULFATE. Yu. A. Koz'min, L. P. Shul'gin, and V. D. Ponomarev (All-Union Mining-Metallurgical Research Inst. of Mon-ferrous Metals and the Lab. of Rare Earth Metals, Academy of Sciences, USSR). Zh. Neorgan. Khim., 9: 2532-5(Nov. 1964). (In Russian)

The solubility product of $EuSO_4$, determined electrochemically, was 1.5×10^{-5} at 25°C. This was close to the value for barium sulfate. The solubility increased with increasing temperature and was considerably higher in KCl solutions. (tr-auth)

7501 BINARY RARE EARTH SODIUM SULFATES. L. L. Zaitseva, M. I. Konarev, A. A. Kruglov, and N. T. Chebotarev. Zh. Neorgan. Khim., 9: 2554-8(Nov. 1964). (In Russian)

Roentgenograms were made of precipitates formed in binary aqueous systems of Na_2SO_4 and each of the following: $La_2(SO_4)_3$, $Ce_2(SO_4)_3$, $Pr_2(SO_4)_3$, $Nd_2(SO_4)_3$, $Sm_2(SO_4)_3$, $Eu_2(SO_4)_3$, and $Gd_2(SO_4)_3$ for Na^+/R^{3+} ratios from 0.5 to 50. Each system showed only one component with a complex crystal structure. X-ray and chemical studies showed the compound $R_2(SO_4)_3 \cdot Na_2SO_4 \cdot 2H_2O$ each Na^+/R^{3+} ratio to be isostructural. Calculated interplanar distances showed that the crystal lattice dimensions decreased with increasing ion radius of the rare earth from La to Gd. (tr-auth)

7502 REACTIONS OF YTTRIUM CHLORIDES WITH CHLORIDES OF OTHER METALS. I. S. Morozov, Z. N. Shvetsova, and Chih-fa Li. Zh. Neorgan. Khim., 9: 2606-12(Nov. 1964). (In Russian)

The reactions of yttrium chloride with the chlorides of Na, K, Ca, Mg, Fe, and Sn were studied by thermal analysis on cocrystallization of these compounds from melts. Phase diagrams of the systems were constructed. In the YCl_3-NaCl system the chemical compound Na_3YCl_6 was observed, which melted incongruently at 552°C. YCl_3 plus KCl formed K_3YCl_6, which melted congruently at 749°C, and KCl · $3YCl_3$, which melted incongruently at 550°C. YCl_3 plus iron chloride formed a limited solid solution and the polymorphic compound $FeYCl_5$ at 360°C. The liquidus areas of the YCl_3-CaCl_2-NaCl and YCl_3-MgCl_2-KCl systems were constructed and the limits of the field of primary crystallization were determined. (tr-auth)

7503 MAGNETIC SUSCEPTIBILITY OF URANIUM(IV) AND URANYL THIOCYANATE COMPOUNDS. V. I. Belova, Ya. K. Syrkin, and E. N. Traggeim (Inst. of General and Inorganic Chemistry, Academy of Science, (USSR). Zh. Neorgan. Khim., 9: 2673-4(Nov. 1964). (In Russian)

The magnetic susceptibilities of three isothiocyanate compounds of U(IV) and of 13 uranyl compounds were measured. An aging effect was observed in one sample of $Cs_4U(CNS)_8$. The cause of this effect is discussed. Paramagnetism, related to the UO_2^{2+} group was lower in the isothiocyanate compounds than in the uranyl compounds. The reasons for this are discussed. (tr-auth)

7504 MAGNETIC RESONANCE OF ^{19}F NUCLEI IN URANIUM AND THORIUM TETRAFLUORIDES. S. P. Gabuda, Yu. V. Gagarinskii, A. G. Lundin, and G. M. Mikhailov (Inst. of Physics, Academy of Sciences, Krasnoyarsk, USSR and Inst. of Inorganic Chemistry, Academy of Sciences, Novosibirsk, USSR). Zh. Strukt. Khim., 5: 789-91(Sept.-Oct. 1964). (In Russian)

Magnetic resonance of ^{19}F in polycrystalline UF_4 and in diamagnetic ThF_4 was studied in order to determine the magnetic properties of the tetrafluorides. The resonance spectra of ^{19}F was also measured in polycrystalline cubic syngony $UF_4 \cdot 2H_2O$ in a 3000 Oe field at 77, 96, and 298°K. The ^{19}F magnetic resonance spectrum in ThF_4 is shaped as an asymmetric singlet. The spectra for UF_4 and $UF_4 \cdot 2H_2O$ are asymmetric and shifted towards stronger fields. In spite of the structure difference, the ^{19}F magnetic resonance spectra for UF_4 and $UF_4 \cdot 2H_2O$ are identical. The data indicate that UF_4 is paramagnetic at room and lower temperatures. (R.V.J.)

7505 THE DETERMINATION OF THE SPEED OF EVAPORATION OF ZrC. N. M. Karnaukhova. Zh. Tekhn. Fiz., 34: 1906-10(Oct. 1964). (In Russian)

Studies were made of high-temperature cathodes with

relatively low rates of evaporation. A method was developed for determining low rates of evaporation. Evaporation products were assembled in a special collector and determined by activation. The method was used for determining the rate of ZrC evaporation at 2300 to 2500°K. (tr-auth)

7506 THE ACCELERATION OF THE URANIUM(IV)–URANIUM(VI) ELECTRON EXCHANGE REACTION BY TARTARIC ACID. Ernest Phillip Benson, Jr. Thesis, East Lansing, Mich., Michigan State Univ., 1963. 107p.

The effect of several organic acids on the exchange reaction between uranium(IV) and uranium(VI) in aqueous perchloric acid was studied. The catalytic effect of these acids was found to increase in the order malonic acid < maleic acid < malic acid ≪ tartaric acid. More detailed studies of the reaction in the presence of tartaric acid revealed that the order of the reaction is 1.3 with respect to uranium(IV) and 0.47 with respect to uranium(VI). The exchange is 0.90 order with respect to tartaric acid and hydrogen ion has an order of −2.9. The predominant uranium species in solution are U^{+4} and UO_2^{++}. Three paths for exchange are combined to give an expression for the overall rate. Rates calculated using this expression agree well with rates obtained experimentally. The rate of the reaction increased with increasing ionic strength and was markedly accelerated by temperature increases. Irradiation with an ultraviolet lamp caused a very large increase in the rate of the reaction. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7507 ADSORPTION OF GASES ACTIVATED BY ELECTRON IMPACT. Harold Franklin Winters. Thesis, Pullman, Wash., Washington State Univ., 1963. 67p.

Adsorption of nitrogen activated by electron impact is shown to result from dissociation of the nitrogen molecule and from the interaction of energetic ions with the surface. Dissociation results from excitation to electronic states whose excitation energies are about 12.5 and 14.3 ev. Dissociative ionization at 24.5 ev also leads to some pumping. Energetic N_2^+ ions have about a 0.85 probability of being adsorbed when they collide with a nickel surface. It is shown that the ion adsorption probability is practically independent of energy between 100 and 30 ev. It is also shown that thermal energy ions have a very low adsorption probability. These results lead to the postulate that the N_2^+ ions dissociate on impact and the atomic nitrogen is subsequently adsorbed. Nitrogen can also be gettered by a hot tungsten filament. Several mechanisms of gettering are discussed, and it is shown that the results indicate nitrogen dissociation at the hot surface. This dissociation was studied as a function of temperature and pressure. For 5×10^{-6} torr < P_{N_2} < 3×10^{-4} torr, the rate of atom formation in nitrogen can be described by the equation $\nu = 7.95 \times 10^{23}$ P exp [−(5.9/KT)]. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7508 A THERMODYNAMIC INVESTIGATION OF AQUEOUS URANYL NITRATE AT 25 AND 0°C. Clarence Florian Hale. Thesis, Boulder, Colo., Univ. of Colorado, 1964. 127p.

A quantitative investigation was made of the hydrolysis of uranyl ion in dilute solutions at 0 and 25°C, in a limited pH and ionic strength range, using a glass and calomel electrode assembly. The data were first converted to hydrogen ion concentrations, then to the appropriate hydrolysis quotients. These latter values were then used to calculate the respective thermodynamic hydrolysis constants. The results showed that the predominate hydrolysis product was $(UO_2)_2(OH)_2^{2+}$. There was also definite evidence for the existence of $(UO_2)_2OH^{3+}$. Thermodynamic values were calculated for the appropriate free energies, enthalpies, and entropies of hydrolysis at infinite dilution. The partial molal aqueous ionic entropies computed for $(UO_2)_2(OH)_2^{2+}$ and $U_2O_5^{2+}$ at 25°C are given along with a discussion of their significance. Conductance measurements were made on aqueous uranyl nitrate solutions for concentrations from near saturation to those in the dilute region at 25 and 0°C, by using three conductance cells possessing various and appropriate constants. The hydrolysis corrections were applied in a most exacting manner so as to enable the calculation of the equivalent conductances of aqueous uranyl nitrate and uranyl ion at infinite dilution for both temperatures. These values confirm the belief that uranyl ion is extremely well hydrated in aqueous solution. In addition some densities at 25 and 0°C were measured for a series of concentrated aqueous uranyl nitrate solutions. It is demonstrated that the partial molal volume of uranyl ion has yet to be measured (although evidence is given for its qualitative value). (Dissertation Abstr., 25: No. 3, Sept. 1964)

7509 EQUILIBRIUM IN THE DEUTERIUM EXCHANGE BETWEEN ACETYLENE AND WATER. James William Pyper. Thesis, Ithaca, N. Y., Cornell Univ., 1964. 81p.

Equilibrium in the deuterium exchange reactions of acetylene and water is studied, both experimentally and by calculations from spectroscopic data. In particular, the equilibrium constant for the reaction C_2H_2 (g) + D_2O (g) = C_2D_2 (g) + H_2O (g) is calculated, using the method of Bigeleisen and Mayer, from spectroscopic data in the literature. K_1 is determined experimentally employing a mass spectrometric method of analysis for the acetylene species and a density method of analysis for the water species. The experimental value of K_1 is 0.759 exp (−144/T) in the temperature range 5°C to 85°C; K_1 at 25°C is 0.468. The four other equilibrium constants in this system are interpreted in terms of this result. The ΔH^0 and ΔS^0 values for the five reactions are calculated and an interpretation given. All the equilibria are shown to be consistent with the rule of the geometric mean and independent of deuterium composition. It is established, by comparison, that the theoretical calculations confirm the experimental results. The present results are compared critically with the early data of Reyerson and Gillespie. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7510 ELECTRON PARAMAGNETIC RESONANCE OF COLOR CENTERS IN POTASSIUM CHLORIDE CONTAINING STRONTIUM CHLORIDE ADDITIVE. Glenn Ernest Conklin. Thesis, Lawrence, Kan., Univ. of Kansas, 1964. 74p.

The microwave and optical absorption properties of F and Z_1 centers in doped single crystals of KCl are studied and the models are determined insofar as possible. The optical and ESR (electron spin resonance) absorption of the F center alone in KCL with divalent ion impurity was studied first because Z_1 centers always appear in conjunction with F centers. The optical and ESR absorption experiments performed for mixtures of F and Z_1 centers were similar to those conducted on F centers alone. The similarity of F and Z_1 centers leads to an interesting difficulty: neither the optical nor the ESR absorption results are resolvable according to the Rayleigh criterion for the limit of resolution. A presumably new method was consequently evolved to analyze the ESR data. By an extrapolation procedure it was found that the Z_1 ESR is characterized by a g value of 1.9952 ± 0.0005 and a derivative peak-to-peak width of 63 ± 1 Oe. A Gaussian shape for the Z_1 ESR is strongly inferred. Optical absorption parameters of $h\nu_{max}$ = 2.068 ± 0.005 ev (599 mμ) and W = 0.290 ± 0.005 ev were found for the Z_1 band at liquid nitrogen temperature. Preliminary results obtained with F and Z_2 centers present indicate that the Z_2 ESR has a slightly larger g value and a somewhat greater width than the Z_1 ESR. The ESR results are compared to earlier measurements by Kawamura and Ishiwatari. An attempt is made to interpret the results by comparing Seitz's model of the Z_1 center to the F center. There are tentative indications that Seitz's model may be appropriate. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7511 ELECTRON SPIN RESONANCE OF Mn^{++}, Eu^{++}, AND Gd^{+++} IN STRONTIUM FLUORIDE. Alan Van Heuvelen. Thesis, Boulder, Colo., Univ. of Colorado, 1964. 70p.

The electron spin resonance of manganese, europium, and gadolinium impurities in strontium fluoride was studied at room and liquid nitrogen temperatures. At liquid nitrogen temperature the manganese hyperfine inter-

action constant A = −106.6 gauss, the spectroscopic splitting factor g = 1.9925, and there is no detectable splitting due to the crystalline electric field. A super hyperfine interaction between the manganese electrons and the fluorine nuclei is observed with the contribution of the manganese s orbitals and p orbitals being approximately A_s = 9.8 gauss and Ap = 4.5 gauss. The low-temperature data for europium in strontium fluoride showed significant crystalline electric field splitting with the fourth and sixth order crystal field constants being respectively C = 207.0 gauss and D = −7.1 gauss. The hyperfine interaction constants for the two europium isotopes with non-zero spin were ^{151}A = 36.5 gauss and ^{153}A = 16.0 gauss, while g = 1.988. The triply charged gadolinium impurity was found to cause a small tetragonal distortion to the usual cubic symmetry of strontium fluoride. The low temperature second, fourth, and sixth order crystalline electric field constants, are respectively, B = −10.0 gauss, C = 209.5 gauss, and D = −1.2 gauss, while g = 1.969. At room temperature the crystal field constants for europium and gadolinium are of the order of 10 per cent less than the liquid nitrogen temperature values. The measurements were made at 8.6 KMc/sec and the concentration of impurities was approximately 0.1 per cent. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7512 THE EFFECT OF UNIAXIAL STRESS ON THE ELECTRON PARAMAGNETIC RESONANCE OF U^{3+} AND Nd^{3+} IN CaF_2. Truman Dodd Black. Thesis, Houston, Tex., Rice Univ., 1964. 74p.

The electron-paramagnetic-resonance spectra of Nd^{3+} and U^{3+} at tetragonal symmetry locations in CaF_2 were investigated while applying a uniaxial stress along the [001] and [101] axes. The measurements were made at 4.2°K and a sensitive X-band superheterodyne spectrometer was employed. The shift in the resonance field was measured with respect to the axial strain, determined by means of a strain gage bonded to the crystals. The effect of strain on these Kramers ions was interpreted as being due to an additional term in the effective spin Hamiltonian of the form $\beta h_{ij} B_i S_j$, where h_{ij} is linearly related to the strain through a spin-lattice coupling tensor, H_{ijlm}, which has seven independent components under C_{4v} symmetry. The C_{4v} symmetry is due to a charge-compensating F^- ion in one of the cubic sites adjacent to the impurity ion. There are then three equally probable symmetry axes corresponding to the cubic axes of CaF_2. This permitted the determination of all seven independent components of H_{ijlm} from the measurements obtained. The components of H_{ijlm} determined from the experimental data were used to calculate the spin-lattice relaxation time due to the direct absorption and emission of phonons by the magnetic ions. The attenuation of elastic waves due to ultrasonic paramagnetic-resonance absorption is also discussed. (Dissertation Abstr., 25: No. 3, Sept. 1964).

7513 FUSED SALTS. Benson Ross Sundheim. McGraw-Hill Series in Advanced Chemistry. New York, McGraw-Hill Book Co., 1964. 442p. $18.50.

Essays on fused-salt research are presented. The information and discussions are presented in chapters on structural aspects of ionic liquids, thermodynamic properties of fused-salt systems, transport properties of liquid electrolytes, electrochemistry in molten salts, the solution of metals in their molten salts, and reaction kinetics in fused salts. (J.R.D.)

7514 EXPERIMENTAL DETERMINATION OF ADSORPTION ISOTHERMS OF LABELED Rb, Cs, AND Co ON Na-, K-, AND Ca-KAOLINITES AND K- AND Ca-MONTMORILLONITES. H. Lange. Thesis, Cologne, Universität, 1964. 71p. $2.00 (Gmelin, AED-DISS. 64-48). (In German)

The results of measurements of the exchange capacity and the specific surface of 4 kaolinites and 3 montmorillonites indicate that in nearly all cases the isotherms are power functions. For the adsorption of Co a linear relation between isotherm slope and specific surface was observed. The selectivity of the two types of minerals is explained with different hydration behavior. (Gmelin Inst.)

7515 MAGNETIC PROPERTIES OF THE TRIIODIDES OF ZIRCONIUM AND HAFNIUM. Alan Robert Janus. Thesis, Syracuse, N. Y., Syracuse Univ., 1964. 84p.

Various methods of preparation of the trihalides of the group IV transition elements were investigated under a wide variety of conditions. Zirconium(III) iodide and hafnium(III) iodide were prepared by aluminum reductions of the corresponding tetrahalides in sealed tube reactions. The compounds were purified by vacuum sublimation. Green and black residues of both compounds were isolated. They were shown to be, for the given metal, chemically and structurally identical. It was shown that the zirconium and hafnium species were isomorphous. An apparatus constructed for the measurement of the magnetic susceptibilities of these compounds over the temperature range 100 to 300°K utilized the Gouy method. The susceptibilities showed a lower temperature dependence than that expected on the basis of antiferromagnetic coupling alone. They also exhibited a field dependence, which was shown to be an inherent property of the substance. On the basis of x-ray-powder-diffraction data, the structure of these compounds was shown to be hexagonal. A layer type of ordering in the structure, which is consistent with this structure, was then proposed to explain the magnetic properties observed. The magnetic properties of the green and black residues of both compounds were similar in each case. The visible absorption spectrum was measured for species obtained on dissolution of the zirconium(III) iodide. Absorption bands were assigned for what is proposed to be the hexaquo zirconium-(III) ion and a less stable iodinated species of the aquo zirconium(III) ion. (Dissertation Abstr., 25: No. 2(Aug. 1964))

7516 MÖSSBAUER EFFECT IN THE SYSTEM $SrFeO_{2.5-3.0}$. P. K. Gallagher, J. B. MacChesney, and D. N. E. Buchanan (Bell Telephone Labs., Inc., Murray Hill, N. J.). 23p. (CONF-543-18)

From American Physical Society 1964 March Meeting, Philadelphia, 1964.

Mössbauer spectra were measured at 4, 78, and 300°K for the two end members and two intermediate samples of the system $SrFeO_{2.5-3.0}$. Of primary interest is the spectrum of strontium ferrate(IV), which at 300°K consists of a single unsplit line having a fullwidth at half intensity of 0.39 mm/sec and an IS_{Cu} of −0.171 mm/sec. At 4 and 78°K the spectra consist of six lines with an IS_{Cu} of −0.079 mm/sec and hfs of 331 and 290 kOe, respectively. There is no evidence of quadrupole splitting, consistent with the cubic perovskite structure. The spectra of the pure iron(III) compound are composed of two sets of six line spectra having IS_{Cu} of +0.126 and −0.047 mm/sec and hfs of 489 and 407 kOe, respectively at 300°K. It was concluded that the structure should contain equivalent amounts of octahedrally and tetrahedrally coordinated iron sites. Subsequent structural analysis confirmed this, and indicated that the phase is isomorphic with brownmillerite. The spectra of the intermediate compounds were found to be more complex and are discussed in terms of accompanying changes in stoichiometry and structure. (auth)

7517 X-RAY DIFFRACTION STUDIES OF NITRATE COMPLEXES OF THORIUM(IV) IN AQUEOUS, NITRIC ACID AND PERCHLORIC ACID SOLUTIONS. Russell D. Larsen and Glenn H. Brown (Kent State Univ., Kent, Ohio). 17p. (CONF-571-16)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Solutions of thorium(IV) nitrate were investigated by the x-ray, radial distribution method using the Waser-Schomaker formalism involving pair interactions. The thorium-(IV) nitrate solutions were prepared in dilute nitric and perchloric acids and in pure water. The radial distribution maxima for all these solutions occur at radial distances of 1.3, 2.8−2.9, 3.6, 4.3, 5.0 Å, and at higher radial distances that could not be interpreted as simple pair interactions. There was no indication in these solutions of Th−Th bonding indicative of metal ion hydrolysis and polymerization found in other studies at lower concentrations of solute and hydrogen ion. The areas under the radial distribution peaks when analyzed and interpreted in terms of pair interactions and the corresponding shape functions all indicate an eight-

coordinate structure of oxygen atoms separated by 2.8 Å from a central thorium(IV) ion. These interactions can be interpreted in terms of the average features of a distorted antiprism. It is proposed that two nitrate ions are coordinated as bidentate ligands to a central thorium(IV) ion with the remaining positions being occupied by water molecules. (auth)

7518 MASS SPECTROMETRIC SAMPLING AND DETECTION OF INTERMEDIATES IN GASEOUS REACTIONS. J. Cuthbert (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 25p. (CONF-649-20)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

Isentropic expansion is shown to take place in sampling through a small pinhole in mass spectrometric studies of gaseous reactions at pressures above a few torr. The flow of CO_2, N_2, and H_2 through a typical pinhole is described by an equation giving a transition region from 5 to 500 torr in which the flow changes from molecular effusion to isentropic expansion; the fractionation of a mixture is discussed briefly. Observations of ions $(CO_2)_n^+$ (n = 1 to 12) showed that isentropic expansion of CO_2 from several atmospheres pressure may give rise to condensation in the sample. Pyrolysis of sample molecules on the ion source filament and heterogeneous removal of free radicals at the ion source walls were examined theoretically. For a mass spectrometer with simple pinhole sampling and a separately pumped filament box, wall reactions may reduce the concentrations of sample radicals at least sixfold and there may be a high probability of detecting pyrolysis products. In a molecular beam mass spectrometer these effects may be negligible, although a much larger sample is required. (auth)

7519 MEANS FOR THE PRODUCTION OF MICRO CRYSTALLINE BORON PHOSPHIDE. Fritz Wenzel (to Siemens-Schuckertwerke AG). German Patent 1,173,878. July 16, 1964. Filed July 13, 1962.

Boron phosphide was produced from elementary, amorphous, or crystalline boron and phosphorus vapor. The device described comprises a vertically arranged reaction tube, which contains an elongated, coaxially arranged holding device for holding the separate supply vessels filled with phosphorus and boron. While the upper end of the reaction tube is closed the lower end is open and in communication with a cooling device. The upper portion of the reaction tube is surrounded by a tubular stove. (Gmelin Inst.)

7520 MULTIPLE TRACER TAGGING TECHNIQUE. William A. Wilson and Arthur C. Herrington (to Standard Oil Co). U. S. Patent 3,149,233. Sept. 15, 1964. Filed June 30, 1960.

A method was developed for determining the loss rate of a finely divided adsorbent solid catalyst from a fluid catalytic conversion unit. The catalyst is uniformly impregnated with a metallic radioisotope by slurrying the catalyst with an inert volatile organic liquid, forming a solution of the radioisotope in an inert volatile organic liquid that is miscible with the other liquid, mixing the slurry and solution to effect impregnation, and drying the resultant impregnated catalyst. A portion of the catalyst is retained and another portion introduced into the conversion unit. The gamma spectra of catalyst samples periodically withdrawn from the inventory of the unit are analyzed and compared with the energy spectra of the retained portion at substantially the same time. These analyses were used to determine the amount of the introduced portion of the impregnated catalyst remaining in the unit as a measure of the loss rate of the catalyst. (M.C.G.)

Organic Chemistry

7521 (AD-421926) THE SYNTHESIS OF β-MERCAPTOETHYLAMINES OF VARYING BASICITY AND LIPOSOLUBILITY. Final Report, June 1959–August 1963. William O. Foye (Massachusetts Coll. of Pharmacy, Boston). Oct. 28, 1963. Contract DA-49-193-MD-2029. 34p. $3.60(OTS).

Derivatives of 2-mercaptoethylamine (MEA) and 2-mercaptoethylguanidine (MEG) have been synthesized to provide radioprotective compounds of lower toxicity than MEA and MEG and which exhibit a fairly wide range of liposolubility. The derivatives have included acyl thioesters, where the acyl groups are derived from straight chain aliphatic acids and α-amino acids, as well as straight chain N-alkyl derivatives of chain length up to fourteen carbons. These derivatives were generally less toxic than the parent compounds, and in several of them good radioprotective activity was retained. Trithiocarbonates of MEA and MEG and some of their derivatives have been prepared and found to have good antiradiation properties. The toxicity of MEA trithiocarbonate is significantly less than that of MEA. Di- or tri-substitution of the nitrogens resulted in reduced activity. Dithiocarbamates of a number of amines and diamines gave radioprotection of a lower order than provided by the mercaptan bases. Other compounds synthesized where little or no activity has been found include mercaptoethyl and dithiocarbamate derivatives of strongly basic heterocycles, and derivatives of mercaptobiacetyl and bithiourea. (auth)

7522 (IS-866) THE EFFECT OF OXYGEN ON THE RECOIL REACTIONS OF CARBON-11 IN HYDROCARBONS. Dale Byron De Vries and A. F. Voigt (Ames Lab., Ames, Iowa). June 1964. Contract W-7405-eng-82. 81p. Dep.; $3.00(cy), 2(mn) OTS.

The recoil reactions of carbon-11 produced by the $^{12}C(\gamma,n)^{11}C$ reaction in benzene, cyclohexane, and n-hexane have been studied. Using gas chromatography for the analysis, the yields of carbon-11-labeled methane, ethane, ethylene, and acetylene were determined. The effect of radiation dose and oxygen scavenger on these yields was investigated. With the exception of acetylene, all the yields observed were found to be sensitive to radiation dose. It was also observed that the extrapolation of product yield versus dose curves to "zero" dose gave the same value for the product yield that was found with oxygen scavenger present. Using these values of product yield, it was found that the acetylene yield increased from benzene to cyclohexane to n-hexane. Very small amounts of methane and no two-carbon products other than acetylene were observed for benzene. The methane yield was larger in cyclohexane than in n-hexane, but the yields of ethane and ethylene were smaller in cyclohexane. These results are discussed in terms of the nature of the recoil carbon-11 atom as it dissipates its kinetic energy in the system. The results are consistent with a mechanism involving the insertion of a $[\cdot\ddot{C}^{11}]$, $[\cdot\ddot{C}^{11}H]$, or $[:C^{11}H_2]$ recoil fragment into a carbon-hydrogen bond of the parent hydrocarbon. The trends observed in the yields of specific products indicate that the insertion reactions take place at energies higher than thermal equilibrium values, and that the most important product determining factor is the nature of the intermediate formed in the insertion process. (auth)

7523 STUDIES ON SOME PRASEODYMIUM AND NEODYMIUM COMPOUNDS OBTAINED BY COMBINATION WITH VARIOUS ORGANIC ACIDS. P. Spacu. Acad. Rep. Populare Romine, Studii Cercetari Chim., 11: 385-97(1963). (In Rumanian)

Twelve new Pr and Nd compounds with various organic acids were synthesized: monobasic acids such as derivatives of benzoic acid (p-aminobenzoic acid, p-aminosalicylic acid, phenylanthranilic acid, and chloromandelic acid); and dibasic acids (mucic acid and adipic acid). The chemical analysis of the synthesized substances as well as the analysis of their solubility was carried out. A spectrophotometric study of these compounds in ultraviolet was also conducted. (Rumanian Sci. Abstr., Nat. Sci., 1: No. 1–2, Jan.-Feb. (1964))

7524 FREE RADICALS DERIVED FROM THE ALKALI SALTS OF NITROFORM (TRINITROMETHANE). Carl Lagercrantz (Univ. of Goteborg). Acta Chem. Scand., 18: 1384-8(1964).

Two different radical species, derived from trinitromethane (nitroform) anions were prepared and their electron spin resonance (ESR) spectra studied. Reduction with substances such as dithionite or cysteine, or electrolytical

reduction of an alkaline solution of potassium nitroform in water, produced free radicals, which exhibited a seven-line ESR spectrum, indicating an interaction of the unpaired electron with three equivalent ^{14}N nuclei. This radical species was interpreted as a trinitromethane anion radical. The second radical species was obtained by heating an alkaline solution of potassium nitroform and glucose on a steam bath. The ESR spectrum exhibited five main groups, each split into a doublet indicating an interaction with two equivalent ^{14}N nuclei and one proton. The spectrum was interpreted as due to a dinitromethane anion radical formed by a hydrolytic cleavage of the parent nitroform anion. The uptake of a proton from the solvent water was confirmed by performing the reaction in D_2O. The doublet splitting was now replaced by a triplet, indicating the interaction with a deuterium nucleus. The spin densities in the radicals concerned are discussed on basis of the measured hyperfine coupling constants. (auth)

7525 HYDROGEN ISOTOPE EFFECT ON THE RATE OF AN INTRAMOLECULAR TAUTOMERIC REARRANGEMENT. Goeran Bergson and Anne-Marie Weidler (Uppsala Univ.). Acta Chem. Scand., 18: 1498-1501(1964).

1-Methylindene, deuterated in the 1-position was synthesized. Its base-catalyzed rearrangement to 3-methylindene was studied under conditions previously found to cause intramolecular and stereospecific proton transfer. Protium was found to migrate 5.5 times as fast as deuterium. (auth)

7526 INTRODUCTION OF ELEMENTO-ORGANIC COMPOUNDS INTO POLYSTYRENE. E. E. Baroni, S. F. Kilin, T. N. Lebsadze, I. M. Roxman, and V. M. Shoniya. At. Energ. (USSR), 17: 497-500(Dec. 1964). (In Russian)

Data are given on preparation of polymers with phenyl compounds containing 12 wt % Pb, 19 wt % Bi, 33 wt % Hg, 12 wt % As, 11 wt % Sn, and 10 wt % Sc. The prepared polymers were transparent and stable in air. Specifications are given for polymers used in scintillation detector construction and in γ and neutron shielding. Data are also given on light recoil from plastic scintillators containing Pb, Hg, and Sn. (tr-auth)

7527 EFFECT OF GLASS SURFACES ON THE LIQUID SCINTILLATION COUNTING OF ALDOSTERONE. Marianne Kandel and A. G. Gornall (Univ. of Toronto). Can. J. Biochem., 42: 1833-7(Dec. 1964).

Studies showed that dilute solutions of pure tritiated aldosterone gave lower counts per minute (cpm) in glass than in plastic vials. One interpretation of this is simply that the adsorption sites on the glass surface are limited in number and, by increasing greatly the proportion of inert to radioactive molecules in solution, the chances of the tritiated steroid being adsorbed become negligibly small. The carrier need not be identical, but it should be a steroid having similar polar properties. As a routine practice it is recommended that 100 μg of hydrocortisone be added when counting dilute solutions of radioactive aldosterone or hydrocortisone. It was also found that the addition of a miscible polar solvent, such as toluene, abolished the effect of the glass surface. (P.C.H.)

7528 ISOTOPE-LABELED INSECTICIDES: SYNTHESIS OF ALPHA-METHYLBENZYL 3-(DIMETHOXYPHOSPHINYLOXY)-CROTONATE LABELED WITH PHOSPHORUS-32 AND CARBON-14. J. C. Potter and W. B. Burton (Shell Development Co., Modesto, Calif.). J. Agr. Food Chem., 12: 439-42(Sept.-Oct. 1964).

Methods are described for the preparation of ^{32}P- and ^{14}C-labeled cis and trans isomers of the insecticide α-methylbenzyl 3-(dimethoxyphosphinyloxy)-crotonate. The ^{14}C preparation was made by the exchange of methanol-^{14}C with the methoxy groups in trimethyl phosphite. The trimethyl-^{14}C phosphite was then reacted with α-methylbenzyl 2-chloroacetoacetate to form α-methylbenzyl 3-(dimeth-^{14}C-oxyphosphinyloxy)-crotonate. The ^{32}P preparation was made by the reaction of ^{32}P-trichloride and methanol. The resulting trimethylphosphite-^{32}P was reacted to form α-methylbenzyl 3-(dimethoxyphosphinyl-^{32}P-oxy)-crotonate. The mixtures of cis and trans crotonate so prepared were separated from each other by column chromatography on Silogel C-22. The purity of the cis isomer was estimated to be 98 to 99%. The yield of the purified cis isomer was 32% in the ^{14}C preparation and 41% in the ^{32}P preparation. The low yield of the ^{14}C preparation is caused by the fact that one third of the ^{14}C is lost as methyl-^{14}C chloride. The amount of exchange of the methanol-^{14}C with the methoxy groups was estimated as 84.2%. The product is used to control a number of important insect pests when used as a spray on dairy cattle. To facilitate measurements of the residues of the insecticide and its metabolites, the compound labeled with ^{32}P and ^{14}C was used. (BBB)

7529 MEDIUM EFFECTS, ISOTOPE RATE FACTORS, AND THE MECHANISM OF THE REACTION OF DIPHENYLDIAZOMETHANE WITH CARBOXYLIC ACIDS IN THE SOLVENTS ETHANOL AND TOLUENE. R. A. More O'Ferrall, W. K. Kwok, and Sidney I. Miller (Illinois Inst. of Tech., Chicago). J. Am. Chem. Soc., 86: 5553-61(Dec. 20, 1964).

It is proposed that the mechanism of the reaction of molecular acids (HA) with diphenyldiazomethane (DDM) in ethanol involves a slow proton transfer to give the ion pair $(C_6H_5)_2CHN_2^+A^-$. This is followed by the expulsion of nitrogen to give a second ion pair $(C_6H_5)_2CH^+A^-$, which may then either collapse to form the ester or dissociate to form benzhydryl ethyl ether. This mechanism is consistent with the second-order kinetics, isotope effect $k_H/k_D = 3.5$ (benzoic-h acid in ethanol-h and benzoic-d acid in ethanol-d), and with an amount of ester in the product ($\alpha = 0.60-0.70$), which is essentially independent of the molecular acid or of deuterium substitution in it. Two factors, the polarity of the medium and the presence of more reactive acid dimers, account for medium effects on the slow step of the reaction of DDM with monomeric carboxylic acids. Thus, the second-order rate constant increases by a factor of 1.5 as the concentration of benzoic acid increases (0.0 to 0.7M); addition of toluene causes the rate constant to drop from 0.69 (ethanol) to 0.42 (85 vol. % toluene) and then rise to 0.73 l mole^{-1} min^{-1} (toluene) at 27°C. In toluene, the apparent second-order rate constant increases with benzoic-h and decreases with benzoic-d acid concentrations resulting in the divergence $k_H/k_D = 1.8-3.7$ (acid 0.015 to 0.25M). It is believed that in toluene it is the dimer that is the reacting acid species and the relatively large concentration dependence is ascribed to a medium effect rather than to changes in acid association. Concerning the product-partitioning steps, it is believed that they are rapid and unselective or essentially diffusion controlled. However, specific "chemical factors," i.e., the polarity of the medium, the nucleophilicity of the solvent, and the strength of added acids, compete with or alter the diffusion rates so that the ester to ether ratio in the products does change. The similarity to product-partitioning steps of solvolysis reactions is emphasized. (auth)

7530 KINETIC ISOTOPE EFFECT IN THE REACTION OF N-METHYLANILINE-N-d AND 3-CHLORO-1-BUTENE. Donald C. Dittmer and Arnold F. Marcantonio (Univ. of Pennsylvania, Pittsburgh). J. Am. Chem. Soc., 86: 5621-6 (Dec. 10, 1964).

The reaction of 3-chloro-1-butene with $C_6H_5NDCH_3$ at 80.2 and 102.3°C in n-heptane in the presence of 2,4,6-collidine was slower than the reaction with $C_6H_5NHCH_3$. The over-all rate of reaction is given by k_2. $[RCl][R_2NH] + k_3[RCl][R_2NH]^2$ and the kinetic isotope effect is observed only in the third-order term, $k_{3H}/k_{3D} = 1.38$(80.2°C), 1.34(102.3°C). A possible interpretation of the data is that the reaction proceeds by two paths. One path is taken by a reaction that corresponds to the second-order term (S_N2' reaction), which does not involve an isotope effect; the other path involves an extra molecule of N-methylaniline, which may be assisting the reaction by hydrogen bonding with the leaving chloride ion. An ion-pair intermediate may be involved in this latter path. (auth)

7531 SYNTHESIS OF SUCROSE LABELLED WITH CARBON-14 IN THE FRUCTOSE PART. E. J. Bourne, J. Peters, and H. Weigel (London Univ.). J. Chem. Soc.: 4605-7(Nov. 1964).

A dextransucrase from Leuconostoc mesenteroides

(Birmingham) was synthesized from sucrose and D-[^{14}C] fructose, sucrose labeled in the fructose part, and other [^{14}C]fructose-containing saccharides. (auth)

7532 A CONVENIENT PREPARATION OF METHANOL-d. A. Streitwieser, Jr., L. Verbit, and P. Stang (Univ. of California, Berkeley). J. Org. Chem., 29: 3706(Dec. 1964).

Preparation of methanol-d by the acid-catalyzed hydrolysis of dimethyl carbonate in D_2O is described. (M.C.G.)

7533 CATALYTIC ACTIVITY OF ERBIUM OXIDE IN THE DEHYDROGENIZATION AND DEHYDRATION OF ALCOHOLS AND DEHYDROGENIZATION OF TETRALIN. A. A. Tolstopyatova, A. A. Balandin, and Chi-chuan Yu (Urals Chemical Research Inst., USSR). Kinetika i Kataliz, 5: 877-80(Sept.-Oct. 1964). (In Russian)

Ethyl, isopropyl, and n-propyl alcohols were dehydrogenated and dehydrated on erbium oxide, but isobutyl alcohol was chiefly dehydrogenated. The activation energies of these reactions and of the dehydrogenation of tetralin were determined. The energies of the C, H, and O bonds with Er_2O_3 were determined by a kinetic method. (tr-auth)

7534 ISOTOPE LABELLING AND MASS SPECTROMETRY OF NATURAL PRODUCTS. Carl Djerassi (Stanford Univ., Calif.). Pure and Appl. Chem., 9: No. 1, 159-78 (1964).

Isotope labeling with deuterium is a powerful and frequently indispensable tool for the structure elucidation of mass spectrometric fragment ions and for gaining insight into the bond fission mechanisms which occur after electron bombardment of alkaloids, steroids, and terpenoids. (N.W.R.)

Radiation Chemistry

Refer also to abstract 8075.

7535 (AD-443451) THE FUNDAMENTAL EFFECTS OF RADIATION AND "HOT ATOMS" ON SIMPLE COMPOUNDS: AN ANNOTATED BIBLIOGRAPHY. Charlie M. Pierce and Richard A. Glass, comps. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Apr. 1963. Contract AF04(657)-787. 328p. (SB-63-37). OTS.

A total of 581 references which are related to the effects of "hot atoms" and radiation on simple compounds and aqueous solutions are listed. Particular attention was given to the halogen compounds. The references are arranged according to the first author. Indexes of corporate author, personal author, and subject are included. The period of coverage dates from 1947 to January 1963. (auth)

7536 (BMI-1695) RADIATION-INDUCED CHANGES IN METHACRYLATE POLYMERS AND THEIR APPLICATION IN POSTIRRADIATION GRAFT POLYMERIZATION. Richard Markle, Francis A. Sliemers, John F. Kircher, William B. Gager, and Robert I. Leininger (Battelle Memorial Inst., Columbus, Ohio). Nov. 11, 1964. Contract W-7405-eng-92. 43p. Dep.; $2.00(cy), 1(mn) OTS.

The effects of gamma irradiation on polymethacrylates in vacuo and polymethylmethacrylate in oxygen were studied. A mechanism for free-radical formation in the polymethacrylates in vacuo was evolved on the basis of ESR studies of radical structures, analysis of volatile products of irradiation, and molecular-weight changes. A tentative scheme of peroxide formation was developed on the basis of this mechanism for free-radical formation. The work indicated that oxygen reduces the amount of chain degradation which occurs in polymethylmethacrylate and that stable peroxides are formed which can be used to initiate polymerization. Polymerization yields depend on the total dose, dose rate, irradiation temperature, and molecular weight utilized in the peroxidation step. Maxima occurred in the yield-versus-dose curves at constant polymerization conditions. Also, as the dose rate was decreased, the polymerization yield first decreased and then increased such that there was a minimum in the yield-versus-dose rate curve at constant dose. This behavior was believed to be a result of the combined effect of (1) net reactive peroxides obtained under a given set of irradiation conditions and (2) the buildup of polymerization-inhibiting fragment molecules or polymer functional groups. (auth)

7537 (NCSC-2477-11) MODIFICATION OF TEXTILE FIBER PROPERTIES BY RADIATION-INDUCED GRAFT POLYMERIZATION. Final Report, November 1, 1958–October 31, 1963. Arthur A. Armstrong, Jr., William K. Walsh, and Henry A. Rutherford (North Carolina State Coll., Raleigh. School of Textiles). Oct. 31, 1963. Contract AT(40-1)-2477. 148p. Dep.; $4.00(cy), 3(mn) OTS.

Applications of radiation and radioisotopes to textiles and textile production processes were investigated. Results of studies concerning radioinduced modification of textile fibers and the effects of graft polymerization are presented. Investigations of radioinduced vapor-phase graft polymerization to textile fibers are reported for areas such as variables affecting the rate of graft polymerization fiber modification by graft polymerization, and kinetics of graft polymerization. (J.R.D.)

7538 (ORNL-3697(p.113-30)) THEORETICAL RADIATION PHYSICS. Jacob Neufeld, R. H. Ritchie, V. E. Anderson, et al. (Oak Ridge National Lab., Tenn.).

Distributions of dose and dose equivalent in anthropomorphic phantoms were computed for protons up to 400 Mev. A theory was developed and a code written to give dose distributions in a proposed high-energy silicon dosimeter from isotropically incident protons of energies up to 400 Mev. Dose distribution with linear energy transfer (LET) was computed for a cylindrical anthropomorphic phantom irradiated with a beam of neutrons. A new fast-neutron spectrometer, the Vectrometer, is described. This device consists of two separated planar arrays of Geiger counters which measure the track lengths of recoil protons resulting from neutron irradiation of the hydrogen gas in the device. A simple expression yields the neutron energy from these track lengths. The simultaneous emission of bremsstrahlung and transition radiation from an electron-irradiated dielectric slab was analyzed theoretically. It was shown that proper measurements of these radiations may be analyzed to yield the mean square scattering angle of electrons in the material. The mean free path of hot electrons in a free-electron gas was determined from many-body perturbation theory. The effect of surface losses upon the stopping power of charged particles was analyzed using a semiclassical approach. The dispersion and damping of surface plasmons were computed from a semiclassical theory. The analysis of the dispersion for a medium in which a linear proton beam interacts with a stationary ionized medium indicates that there is a multiple instability. An analysis was made of a dispersion equation for a medium in which a helical electron beam interacts with a stationary plasma. The interaction of an ion beam of small intensity moving with velocity $c\beta$ (where c is the velocity of light) through a stationary plasma was investigated under the assumption that the beam and the waves resulting from the interaction are aligned along the direction of an impressed static magnetic field and that the frequencies of the excited waves are sufficiently high so that the motion of the ions perturbed by these waves can be neglected. A plasma-beam system is investigated in which an electron beam of small intensity moving with velocity βc interacts with a cold plasma immersed in a magnetic field. It is assumed that the beam and the excited wave resulting from the interaction are aligned along the direction of the magnetic field and that $(1 - \beta^2) \gg 1/\eta$, where η is the ion-to-electron mass ratio. The frequencies and growth rates of the excited waves are calculated. (auth)

7539 (ORNL-3697(p.131-43)) EXPERIMENTAL RADIATION PHYSICS. R. D. Birkhoff, E. T. Arakawa, T. E. Bortner, et al. (Oak Ridge National Lab., Tenn.).

The interaction of low-energy electrons with benzene derivatives was studied, using the swarm method. Control of the energy distribution in the electron swarm was achieved, which allows discrimination between the differ-

ent electron capture processes. Improvements in the electron time-of-flight technique for electron diffusion measurements using a Geiger counter detector were made. A new method was worked out, and equipment was constructed for determining oscillator strengths for electronic transitions in the vacuum ultraviolet region. An experiment is being developed which will determine the lifetime of temporary negative ions produced by unimolecular electron capture. Monochromatic light from electron plasmon decay was observed for the first time from aluminum foils a few hundred angstroms in thickness bombarded by 80-kev electrons. The optical constants of evaporated silver films were determined between 2500 and 3700 A, the region of the Wood's transparency. The Keplertron was used to study Auger electron production in infinite isotropic radioactive copper media. The continuous slowing-down model neglects Auger production, which therefore must be studied experimentally. An electron slowing-down spectrum in gold was measured. (auth)

7540 (ORNL-3697(p.144-52)) PHYSICS OF TISSUE DAMAGE. R. D. Birkhoff, J. G. Carter, R. A. MacRae, D. R. Nelson, and M. Y. Nakai (Oak Ridge National Lab., Tenn.).

The optical reflectivity of hot-pressed pyrolytic graphite was measured from 1100 to 3000 A. The optical constants showed that an electron resonance occurs at 6.9 ev. A new technique was developed for measuring charged-particle interactions in layers a few hundred atoms thick. These layers are vacuum evaporated on a thin silicon monoxide insulator and thus need not be self-supporting. Range measurements on protons from 2 to 10 kev were made with this method. Further work on the time-of-flight electron beam monochromator resulted in a gun which produced a 2-nsec burst of electrons, an improved transistor amplifier, positive proof that the electron drift time is characteristic of its energy, and some preliminary observations of nitrogen vibrational excitation by 2-ev electrons. Vacuum diffusion pump oil was irradiated and then used in the pump. A trace amount of the radioactive oil escaped into the vacuum system, where it deposited on the walls to a maximum depth of 6 A. The gas effect noted in thermoluminescence experiments was found to be a temperature effect with the gas playing the role of a heat transfer agent. Sample holders were fabricated from boron carbide. (auth)

7541 (RAI-331) RADIATION-INDUCED SOLID PROPELLANT DECOMPOSITION. Technical Report, December 1, 1962–November 30, 1963. George Odian, Terese Acker, Thomas Pletzke, Ernest Henley, and R. F. McAlevy, III (Radiation Applications Inc., Long Island City, N. Y.). Jan. 15, 1964. Contract AF49(638)-1125. 30p. (AD-604475; AFOSR-64-1448). $2.00(OTS).

An investigation was made of the effect of ionizing radiation on the burning rates and tensile strengths of various composite ammonium perchlorate propellants. The results of these studies demonstrated that, in many cases, drastic changes in burning rate and tensile strength occurred upon radiolysis. In order to elucidate the mechanism of these effects, a multi-pronged study of the effects of radiation on propellants and propellant components was initiated. This involved: (1) a study of the radiation-induced decomposition of ammonium perchlorate with an elucidation of the various chemical species produced upon radiolysis and their yields (G values); (2) a study of radiation effects on burning rate by a technique in which the effect of radiation on each of the two components of a propellant, i.e., organic binder and inorganic oxidizer, is studied separately. (auth)

7542 THE EFFECT OF HEAT AND OF UV-LIGHT ON X-RAY INDUCED ESR-CENTERS IN α-ALANINE. Tor Brustad and Jorolf Dyrset (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Acta Chem. Scand., 18: 1559-61(1964).

The qualitative and quantitative changes of x-ray-induced electron spin resonance (ESR) signals in α-alanine, when subjected to subsequent treatment either with uv light or with heat, were studied. The number of ESR centers in samples exposed to uv light or heat after x-ray irradiation showed a pronounced decrease during the first hours of treatment, followed by a slighter decrease as the treatments continued. (M.C.G.)

7543 MEASUREMENT OF ELECTRON SPIN RESONANCE DIFFERENCE SPECTRA AT 77°K. APPLICATIONS OF THE METHOD IN LOW-TEMPERATURE RADIATION CHEMISTRY. D. R. Smith and J. J. Pieroni (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 42: 2209-14(Oct. 1964). (AECL-2047)

The technique of measuring ESR difference spectra was extended to 77°K. This enables elimination of the main signal due to irradiated silica sample tubes and of about 90% of the hydrogen atom signal from the same source. Under certain conditions, e.g. when the ESR spectrum due to one species can be photochemically bleached, the method permits resolution of two superimposed spectra. This was demonstrated by measurements that resolve the ESR singlet due to trapped electrons in irradiated tetrahydro-2-methylfuran from the underlying septet. These developments have rendered the ESR difference method very useful for the study of paramagnetic species formed in systems which have been γ irradiated at 77°K. (auth)

7544 RADIOLYSIS OF AQUEOUS BROMAL HYDRATE SOLUTIONS; DETECTION OF OXALIC AND GLYOXYLIC ACIDS. R. L. Eager, R. W. O'Donnell, and L. J. Tusz (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 42: 2621-3(Nov. 1964).

Results indicated that both oxalic and glyoxylic acid are formed in addition to hydrobromic acid when bromal hydrate solutions are irradiated with ^{60}Co gamma rays. The mechanism predicts the formation of one molecule of oxalic acid for every three of hydrobromic acid produced. (F.S.A.)

7545 EFFECTS OF pH IN THE γ-RADIOLYSIS OF AQUEOUS SOLUTIONS OF CYSTEINE AND METHYL MERCAPTAN. D. A. Armstrong and V. G. Wilkening (Univ. of Alberta, Calgary). Can. J. Chem., 42: 2631-5 (Nov. 1964).

The radiolysis of aqueous solutions of cysteine were studied as a function of pH in water to elucidate the reactions of the reducing species H and e^-_{aq}. In acid solution it appeared that the e^-_{aq} reacts via $e^-_{aq} + RSH \rightarrow R + SH^-$; above pH 4 the reaction $H + RSH \rightarrow RS + H_2$ predominated. These conclusions were supported both by kinetic analysis and product yields of hydrogen and methane. (F.S.A.)

7546 INVESTIGATIONS ON RADIATION INDUCED AND CONVENTIONAL OXIDATION OF PARAFFINE. Nadzieja Krawczykowa, Irene Balcerzakowa, and Stanislaw Ciborowski (Inst. of General Chemistry, Warsaw). Chem. Stosowana, Ser. A, 8: 453-64(1964). (In Polish)

Investigations were carried out on the oxidation of the liquid paraffin by air at atmospheric pressure and in the temperature range from 130 to 150°C. The possibility of performing the process without use of any catalyst was studied. The oxidation process was initiated by adding to the system some quantity of partially oxidized paraffin containing hydroperoxides. This paraffin was obtained by radioinduced oxidation using gamma rays (74 r/sec). Such oxidation proceeded without an induction period. The acid number at 130°C, after 6 hr was equal to 5. The amount of peroxides equaled to 5.6 mg O_2 per gram of the paraffin being oxidized. In a 10-hr process performed without irradiation the acid numbers were equal to about 2 after 6 hr, and to 5 after 10 hr. In the process performed with $KMnO_4$ catalyst (0.1%) the acid numbers after 6 and 10 hr were equal to 5.5 and 13, respectively. No enrichment in hydroperoxides took place. The addition of an adequate quantity of partially oxidized paraffin to the fresh one brought about a quick initiation of the reaction even at small contents of hydroperoxides in the initial mixture. For instance, in a mixture containing 0.106 mg O_2/g of hydroperoxides, the acid numbers after 6 and 10 hr at 130°C reached the figures 5.5 and 16, respectively. The increase of hydroperoxide in the initial mixture did not exert any larger influence on the reaction course. The influences of the air-flow rate and water vapor content in the air on the oxidation process were examined. Both fresh and reflux paraffin were used in these studies. The results obtained made possible an

approximative determination of optimum parameters of the process to be performed in technical scale. (auth)

7547 INVESTIGATIONS ON THE INFLUENCE OF NEUTRON IRRADIATION ON THE STRUCTURE OF APATITE. Włodzimierz Bobrownicki and Józef Jarmakowicz (Inst. of Chemistry and Physics, Polish Academy of Sciences, Wroclaw). Chem. Stosowana, Ser. A, 8: 475 (1964). (In Polish)

Effects neutron bombardment on the crystalline lattice of the fluoroapatite $[Ca_5(PO_4)_3F]$ were studied. Because the heat of formation of fluoroapatite is low, it was expected that after irradiation in a nuclear reactor some changes in the lattice would take place resulting in a solubility increase in 2% citric acid. A synthetic apatite showing 2.8% solubility of P_2O_5 in citric acid was used. Two samples of this compound were irradiated in the reactor Ewa, together with two cobalt standards from which the mean neutron flux was calculated. One sample was irradiated 86 hr with a neutron flux of 2×10^9 neutrons/cm^{2}sec, the other for 168 hr 35 min with a neutron flux of 1.6×10^9 neutrons/cm^{2}sec. The solubility of P_2O_5 in 2% citric acid was then determined. The results (2.9%) were, however, within the limits of experimental error, the same as those for a nonirradiated sample. The x-ray diagrams did not reveal any changes in the apatite lattice. It was concluded that the negative result is brought about by the too low a neutron flux or perhaps by the too low a number of high-energy neutrons. (auth)

7548 BORAZARENES AND BORAZOLES. FLUORESCENCE SPECTROMETRY AND QUANTUM EFFICIENCIES IN RELATION TO SLOW NEUTRON COUNTING. E. A. Rojo, G. J. Videla, M. A. Molinari, O. A. Lires, and L. H. Casas (Comision Nacional de Energia Atomica, Buenos Aires). Intern. J. Appl. Radiation Isotopes, 15: 611-16 (Oct. 1964).

Some borazole derivatives and borazarenes for which luminescent properties were predicted, were prepared and fluorescence spectra and quantum yield with uv excitation were obtained, as a preliminary study for their use as slow neutron scintillation detectors. Counting experiments with slow neutrons are in progress with satisfactory results. (auth)

7549 EPR SPECTRA OF IRRADIATED FROZEN AQUEOUS SOLUTIONS. 1. ALKALINE SOLUTIONS. B. G. Ershov, A. K. Pikaev, P. Ya. Glazunov, and Vikt. I. Spitsyn (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 1755-61(Oct. 1964). (In Russian)

The radical products in irradiated frozen H_2O and D_2O solutions of KOH for different concentrations at temperatures from −196 to −100°C were studied by EPR (electron paramagnetic resonance) methods. The hydrated electron was stabilized and the OH radicals were converted to the $O^- \cdot nH_2O$ ion radicals. H and D atoms were found at −196°C. The thermal stability of the radical products was studied in neutral and alkaline solutions at −196 and −150°C. The yields of the radical products in alkaline media were higher than in neutral. (tr-auth)

7550 MONONEGATIVE MOLECULAR IONS OF AROMATIC HYDROCARBONS IN γ-IRRADIATED ORGANIC GLASSES. N. Christodouleas and W. H. Hamill (Univ. of Notre Dame, Ind.). J. Am. Chem. Soc., 86: 5413-16 (Dec. 20, 1964).

The electronic spectra of the mononegative molecular anions of biphenyl, anthracene, phenanthrene, 1,2-benzanthracene, triphenylene, o-terphenyl, pyrene, triphenylethylene, tetraphenylethylene, cycloheptatriene, and hexamethylbenzene produced in γ-irradiated organic glasses at 77°K. were investigated. Relative anion formation efficiencies were determined. The spectrum of γ-irradiated perylene was investigated and attributed to the perylene monopositive ion. (auth)

7551 ENHANCEMENT OF FLUORESCENCE YIELD OF CHELATED LANTHANIDE IONS BY LEWIS BASES. Marcos Kleinerman, R. J. Hovey, and D. O. Hoffman (American Optical Co., Southbridge, Mass.). J. Chem. Phys., 41: 4009-10(Dec. 15, 1964).

Studies showed that the use of Lewis bases enhances the fluorescence yield of liquid, plastic, and glassy solutions of trivalent Tb, Eu, and Sm chelates, including Tb dibenzamide, Eu dibenzoylmethide, Eu thenoyltrifluoroacetonate, Eu benzoylacetonate, and Sm thenoyltrifluoroacetonate. The Lewis bases that increase the fluorescence efficiency of solutions of the chelates in hydrocarbon solvents include acetone, dimethyl sulfoxide (DMSO), tri-n-butyl phosphate (TBP), dimethylformamide (DMF), tri-n-octyl phosphine oxide (TOPO), tri-n-butyl phosphorothioate (TBPT), and a large number of amines, both aliphatic and aromatic. None of the bases investigated was equally effective for all the chelates listed. The mechanism of the enhancement effect is discussed. (P.C.H.)

7552 ESR SPECTRA OF γ-IRRADIATED POLYCRYSTALLINE POWDERS OF SOME FLUORINE-CONTAINING COMPOUNDS. Machio Iwasaki, Kazumi Toriyama, and Brunzo Eda (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys., 42: 63-5(Jan. 1, 1965).

The powder spectra of γ irradiated salts and amides of some fluorinated acids were interpreted based on the spectral shapes of the α-fluorine hyperfine-coupling line. Because of the large anisotropy of α-fluorine coupling tensor, it was possible to observe the shoulders corresponding to the maximum principal value of the coupling tensor. The separation between the wing patterns and the wing hyperfine structures made it possible to identify the radical species produced. The probable radicals were the ones formed by the removal of the atoms attached to the α carbon. (auth)

7553 FRAGMENT IONS FROM CH_3CHO AND $(CH_3)_2CO$ ELECTRON IMPACT. F. H. Dorman (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Chem. Phys., 42: 65-8(Jan. 1, 1965).

The ionization-efficiency curves for the parent and fragment ions from CH_3CHO and $(CH_3)_2CO$ were examined by the second differential method. The appearance potentials for CH_3CO^+, namely, 10.2 ± 0.1 ev [$(CH_3)_2CO$] and 10.5 ± 0.2 ev (CH_3CHO), are much lower than previously accepted electron-impact values. Apart from $CO^+(CH_3CHO)$ no appearance potentials can be easily obtained for any of the other fragment ions. No kinetic energy was found for the light ion CH_3^+, nor the heavier ions CO^+, $HCO^+(CH_3CHO)$, and $CH_3CO^+[(CH_3)_2CO]$. (auth)

7554 ANISOTROPIC HYPERFINE STRUCTURE IN ESR SPECTRA: APPLICATIONS TO IRRADIATED CRYSTALS OF MALONAMIDE AND GLYCINE. H. N. Rexroad, Yu Hak Hahn, and Wade J. Temple (West Virginia Univ., Morgantown). J. Chem. Phys., 42: 324-30(Jan. 1, 1965).

The electron spin resonance spectrum resulting from the anisotropic coupling with one proton is known to consist of two doublets whose splittings and intensities depend on frequency as well as orientation of the magnetic field. The possible appearance of both doublets in the same spectrum can be used to aid the analysis of complicated spectrum. It is used here to establish the existence of more than one radical species in irradiated malonamide and to verify the $H_{(C)}$ coupling constants in $NH_3^+(\dot{C}H)CO_2^-$ that were reported earlier by others in γ irradiated glycine. A hyperfine coupling tensor having principal values of −29, −59, and −89 Mc/sec was observed in γ irradiated malonamide and used to identify the radical $\dot{C}H(CONH_2)_2$ with the spin density concentrated in a p-orbital of the central carbon atom. The theory of anisotropic magnetic hyperfine interactions is extended to include coupling cases other than a single nucleus with spin ½ and the experimental conditions required for observation of more than the usual 2I + 1 hyperfine lines were examined. (auth)

7555 EFFECT OF ELECTRICAL FIELDS AND DENSITY IN THE RADIOLYSIS OF ETHANE. Halbert H. Carmichael, R. Gorden, Jr., and P. Ausloos (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 343-51(Jan. 1, 1965).

The gamma radiolysis of $C_2H_6-C_2D_6-NO$ and CH_3CD_3-NO mixtures was investigated as a function of applied electrical field. In the saturation current region, a number of products resulting from the decomposition of neutral excited molecules increase about fivefold before the onset

of secondary ionization while several other products, which can be ascribed to ion molecule reactions, remain essentially unchanged. The modes of decomposition of the excited ethane molecules formed by electron impact, as derived from the applied field experiments, are the same as those observed in the vacuum ultraviolet photolysis at 1470 and at 1236 Å. From the isotopic composition of the products it could be deduced that the average energy transferred to ethane by electron impact is greater than 10 ev. A value of 0.5 was derived for the number of neutral excited molecule decompositions per ion pair. A change in density has a pronounced effect on the product distribution, both in the photolysis at 1236 Å and the radiolysis. In the radiolysis, several of the changes can be ascribed to the diminishing fragmentation of the parent ion with an increase in density. However, products resulting from the fragmentation of the neutral excited ethane molecules formed in the radiolysis also show a strong dependence on density because of collisional stabilization of the primary fragments and of the products formed in secondary reactions. For instance, the propane which could be entirely ascribed to the insertion reaction $CH_2 + C_2H_6 + M \rightarrow C_3H_8 + M$ increases with an increase in density in the photolysis as well as in the radiolysis. (auth)

7556 IONIC REACTIONS AND RADIOLYSIS OF CH_4. M. S. B. Munson, F. H. Field, and J. L. Franklin (Humble Oil and Refining Co., Baytown, Tex. and Rice Univ., Houston, Tex.). J. Chem. Phys., 42: 442-3(Jan. 1, 1965).

Several ionic reactions in the radiolysis of methane as postulated by others are discussed. Specific instances of mass spectrometric observations and negative evidence are mentioned. It is stated that small amounts of O_2 will not have a major effect on ionic reactions of primary and secondary ions in the radiolysis of methane. Also, experiments on ionic reactions in propane and butane gave no evidence for the existence of stable $C_3H_9^+$ or C_4H_{11}. Consequently, it would be expected that if the postulated proton transfer from CH_5^+ to propane or heavier hydrocarbons occurred, the pronated paraffin complex would dissociate immediately. (P.C.H.)

7557 ESR SPECTRA FOR THE t-BUTYL RADICAL TRAPPED IN A SOLID. Howard Shields and Philip Hamrick (Wake Forest Coll., Winston-Salem, N. C.). J. Chem. Phys., 42: 443-4(Jan. 1, 1965).

The t-butyl radical was identified in pivalic acid with ESR after x irradiation. The ESR spectra were obtained after exposure to ~ 10^6R of x irradiation at 50 kv. The samples were irradiated at 130°K and observed at different temperatures with a variable temperature control, working on the principle of a heat exchanger. The x-irradiated sample of pivalic acid gave an ESR spectrum that resulted from a superposition of spectra from two different radicals. One spectrum contained ten absorption peaks equally spaced and having a Gaussian intensity distribution with ratios of 1 : 9 : 36 : 84 : 126 : 84 : 36 : 9 : 1. The number of peaks in this spectrum and the intensity distribution agree with the theoretical ESR spectrum expected from a t-butyl radical $C\text{-}(CH_3)_3$, where the unpaired electron interacts equally with the nine hydrogen nuclei through hyperconjugation. (P.C.H.)

7558 DIRECT AND INERT-GAS-SENSITIZED RADIOLYSIS AND PHOTOLYSIS OF METHANE IN THE SOLID PHASE. P. Ausloos, R. E. Rebbert, and Sharon G. Lias (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 42: 540-8(Jan. 15, 1965).

The photolysis of CH_4-CD_4 mixtures was briefly investigated at 20.4°K using the xenon and krypton resonance lines. From the isotopic composition of the hydrogen and ethane fractions, it could be derived that, in the solid phase, methylene and methyl radicals are produced. The methylene radicals, which are formed by the process $CH_2^* \rightarrow CH_2 + H_2$, inserted into methane to form ethane. In argon-sensitized radiolysis at 20.4 and 77°K, the hydrogen-molecule elimination process predominated, indicating that neutral excited-methane molecules are formed nearly exclusively. In the xenon-sensitized radiolysis, however, mainly hydrogen atoms and methyl radicals were observed. In all inert gas-sensitized radiolyses, there was a gradual decrease in the efficiency of the energy transfer with increasing dilution. In direct radiolysis, hydrogen atoms played a more important role than in photolysis at 1236 Å. Radiolysis of $CD_4-C_2H_4$ (1 : 0.01) mixtures indicated that, at 77°K, hydrogen atoms react with ethylene and propylene to form higher saturated hydrocarbons while, at 20.4°K, hydrogen atoms disappear mainly by recombination with other free radicals. From the isotopic composition of the ethylene fraction formed in the radiolysis of $Ar-CH_4-CD_4$ mixtures, it was surmised that a fraction of the methylene recombines to form ethylene. (auth)

7559 PULSE RADIOLYSIS STUDIES. VII. THE ABSORPTION SPECTRA AND RADIATION CHEMICAL YIELDS OF THE SOLVATED ELECTRON IN THE ALIPHATIC ALCOHOLS. Myran C. Sauer, Jr., Shigeyoshi Arai, and Leon M. Dorfman (Argonne National Lab., Ill.). J. Chem. Phys., 42: 708-12(Jan. 15, 1965).

The absorption spectra of the solvated electron in five aliphatic alcohols were determined by the pulse radiolysis method. For the alcohols: ethylene glycol, methanol, ethanol, n-propanol, and isopropanol, the absorption maxima showed a red shift with decrease in the value of the static dielectric constant. The absorption maxima for these alcohols are, respectively, 5800, 6300, 7000, 7400, and 8200 Å. The molar extinction coefficient at the maximum and the oscillator strength of the broad absorption band was determined for each alcohol. The radiochemical yields of the solvated electron in these irradiated alcohols as determined by pulse radiolysis are, respectively, 1.2, 1.1, 1.0, 1.0, and 1.0 per 100 ev. The correlation between the transition energy for optical excitation of the solvated electron and the dielectric behavior of the liquid is discussed in terms of the theory. (auth)

7560 ANOMALOUS THERMOLUMINESCENT KINETICS OF IRRADIATED ALKALI HALIDES. J. A. Partridge and C. E. May (Lewis Research Center, Cleveland). J. Chem. Phys., 42: 797-8(Jan. 15, 1965).

The isothermal decay characteristics and kinetic order of alpha-irradiated NaCl, KCl, and KBr were studied. An apparent kinetic order of less than one was found for all three salts and was common to nearly all the sources. Such anomalous kinetics indicated that more than a single process is involved. Single crystals were irradiated in the as-received condition at room temperature using either 10-Mev protons, 40-Mev alphas, or 2-Mev electrons. The kinetic results were found to be independent of the irradiation particle over the range of flux levels employed (10^{14} to 10^{17}/cm^2). Only one glow peak resulted in the temperature range from 25 to 300°C, and it was composed of a single spectral band. Results indicated that the kinetics are associated with the absence of OH^- ions. (M.C.G.)

7561 UNSTABLE INTERMEDIATES. PART XXIII. SOLVATED ELECTRONS: STABILIZATION IN AQUEOUS ALKALI-METAL HYDROXIDE GLASSES. M. J. Blandamer, L. Shields, and M. C. R. Symons (Univ. of Leicester, Eng.). J. Chem. Soc.: 4352-7(Nov. 1964).

Aqueous alkali-metal hydroxide glasses after exposure to γ radiation at 77°K are characterized by an intense absorption band at about 17,000 cm^{-1} which is lost on exposure to visible light. Comparison of the electron resonance spectra before and after bleaching suggested that the blue species is paramagnetic, having a symmetrical absorption band of width about 14 gauss and a g-factor of 2.000. The nature of this species is discussed and it is postulated that the entity is an electron trapped at a hydroxide vacancy. The effect of added halide ion on the electron resonance spectra was examined. A second species, having $g_\parallel = 2.002$ and $g_\perp = 2.07$, is discussed in terms of an O^- radical strongly perturbed by the medium. (auth)

7562 UNSTABLE INTERMEDIATES. PART XXV. THE RADICAL PF_4. P. W. Atkins and M. C. R. Symons (Univ. of Leicester, Eng.). J. Chem. Soc.: 4363-8(Nov. 1964).

The electron spin resonance spectrum of a radical in γ-irradiated ammonium and potassium hexafluorophosphate, identified by Morton (Can. J. Phys., 41: 706(1963))

as PF_4, was studied between 77 and 300°K. The results are discussed in terms of an orbital-level scheme for the tetrahedral cation PF_4^+ and it was concluded that the unpaired electron causes considerable distortion from T_d symmetry, but that at room temperature rapid inversions render all the fluorines equivalent. Outer orbitals for the families MnO_4^-; MnO_4^{2-}; MnO_4^{3-} and PF_4^+; PF_4; PF_4^- were compared, and it was concluded that the 3d level plays a relatively minor role in the latter family. (auth)

7563 α-ANNEALING OF RECOIL ATOMS IN CHROMATES. P. N. Dimotakis and M. I. Stamouli (Nuclear Research Centre Democritus, Athens). J. Inorg. Nucl. Chem., 26: 2045-52(Dec. 1964).

Annealing studies of recoil ^{51}Cr in mixtures of chromates and dichromates with boron compounds by α particles produced from the $^{10}B(n,\alpha)^7Li$ nuclear reaction, are reported. Only potassium chromate showed a considerable increase of retention, while α particles had no direct effect on ammonium chromate or caused a decrease of retention in potassium dichromate. The post-irradiation isothermal annealing seemed to be affected by the dose given to the lattice by α particles. (auth)

7564 THE MÖSSBAUER EFFECT IN SOME ORGANIC TIN HALIDES. M. Cordey Hayes (Birmingham Univ., Eng.). J. Inorg. Nucl. Chem., 26: 2306-8(Dec. 1964).

Measurements were made of the isomeric shift and quadrupole splitting of Mössbauer spectra of organic tin halides. (M.C.G.)

7565 RADIOLYSIS OF CRYSTALLINE LITHIUM BROMATE BY LITHIUM-6 FISSION RECOIL PARTICLES. G. E. Boyd and T. G. Ward, Jr. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 68: 3809-14(Dec. 1964).

Measurements were made of the decomposition of BrO_3^- ion and the production of oxidizing fragments in crystalline $LiBrO_3$ by energetic tritons and α particles released following neutron capture by ^6Li in the Oak Ridge graphite reactor. A strong dependence of the radiolysis on the linear energy transfer (LET) was indicated by the initial 100-ev yield for bromate decomposition, $G_0(-BrO_3^-) = 1.48$, which was five times larger than that obtained with ^{60}Co γ rays. A correspondingly large yield of oxidizing fragments also was observed; this yield and the ease with which these fragments could be removed from the crystals by mild thermal annealing was interpreted as being inconsistent with a "thermal spike" radiolysis mechanism. The observation that the yields, $G_0(-BrO_3^-)$, G_0("Ox"), and $G_0(Br^-)$, all were approximately five times those observed with γ rays also suggested that the mechanism for the radiolysis did not change with increasing LET. A tenfold increase in the dose rate caused no change in the yields either for bromate decomposition or oxidizing fragment production. (auth)

7566 PULSE RADIOLYSIS STUDIES OF AQUEOUS SODIUM CHLORIDE SOLUTIONS. M. Anbar and J. K. Thomas (Argonne National Lab., Ill.). J. Phys. Chem., 68: 3829-35(Dec. 1964).

The reaction of OH radicals with chloride ions was studied by the pulse radiolysis technique. The product of the reaction was identified as Cl_2^-, and its rate of formation was studied. The effects of OH radical and solvated electron scavengers on the Cl_2^- yield indicated that the former radicals produced the Cl_2^-. The rate of production of the Cl_2^- was independent of oxygen concentration, first order in $[H^+]$ from pH 3 to 0, and first order in chloride ion and hydroxyl radical concentrations. At pH < 3, $G(Cl_2^-)$ was independent of pH and of $[Cl^-]$ and corresponded to G(OH). However, at pH 7 $G(Cl_2^-)$ depended on $[Cl^-]$ up to 3M and was less than that in acid solution. The results demonstrated the importance of hydrogen ions in the formation of Cl_2^- and suggested that in neutral solution Cl_2^- may be formed in the "spur" regions. The mechanisms of Cl_2^- formation are discussed. (auth)

7567 DIRECT OBSERVATION OF TRANSIENT INTERMEDIATES IN THE PULSE RADIOLYSIS OF ISOBUTYLENE. E. J. Burrell, Jr. (E. I. du Pont de Nemours & Co., Wilmington, Del.). J. Phys. Chem., 68: 3885-6(Dec. 1964).

Transient ionic species were observed in radioinduced polymerization of isobutylene. The absolute rate constant for termination was also determined. Two principal methods of observation were employed: transient ultraviolet absorption spectroscopy and transient dielectric constant measurements. The radiation source was a Varian linear electron accelerator. (M.C.G.)

7568 MAGNETISM OF RADIATION-DAMAGED LiF. A. Van Den Bosch (SCK-CEN, Mol, Belg.). J. Phys. Chem. Solids, 25: 1293-1304(Dec. 1964).

The absolute magnetic susceptibility of lithium fluoride single crystals, irradiated with thermal neutrons, was found to consist of three parts: a diamagnetic part, $\chi_d = -0.408 \times 10^{-6}$ emu/g, due to the normal LiF matrix; a temperature-dependent paramagnetic part, obeying the Curie law, attributed to unpaired electrons; and a temperature-independent paramagnetic part arising from the presence of metallic lithium. The data obtained on crystals irradiated to doses between 8×10^{15} and 8×10^{18} neutrons/cm^2 are discussed from the point of view of radiation damage. Optical absorption, x-ray, and density measurements were performed on samples of known susceptibility. These data as well as those available in the literature were used to correlate all of the observed processes. The radiation damage phenomena can be understood qualitatively if it is assumed that primary defects are created continuously during neutron irradiation. The various physical effects are then explained by the ways in which those defects can agglomerate. (auth)

7569 SOME PROPERTIES OF THE VISIBLE LUMINESCENCE EXCITED IN DIAMOND BY IRRADIATION IN THE FUNDAMENTAL ABSORPTION EDGE. P. J. Dean and J. C. Male (King's Coll., London). J. Phys. Chem. Solids, 25: 1369-83(Dec. 1964).

The properties of the visible ("blue band" or "band A") luminescence, which is excited in natural and synthetic diamonds by electromagnetic radiation of quantum energy near the fundamental absorption edge and also by energetic charged particles, were contrasted with those of the better known visible luminescence systems (4150, 4968,5030, 5755 Å series etc.). The effects of temperature, external electric and magnetic fields, and irradiation damage produced by 500 kev electrons are discussed and tentatively interpreted in terms of a process in which secondary energy is transferred to the band A emission centers by excitons and electron-hole pairs. The temperature dependence of the integrated intensity and the decay time of the band A luminescence is shown to be consistent with a configurational coordinate description of the energy levels of the emission center. The radiative decay time of the excited state was $\sim 10^{-2}$ sec at 80°K. Above ~100°K, a radiationless de-excitation process was observed with a thermal activation energy of 0.36 ± 0.02 ev. (auth)

7570 EPR INVESTIGATIONS ON THE EARLY STAGES OF THE RADIATION-INDUCED OXIDATION OF PALMITIC ACID AND ITS DERIVATIVES. A. A. Revina and N. A. Bakh (Inst. of Electrochemistry, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 769-75(Sept.-Oct. 1964). (In Russian)

Free radicals in palmitic acid, potassium palmitate, and tripalmitin irradiated at 77°K in a vacuum were studied by an EPR method. The differences in radical structure and yield and in kinetics of formation and destruction indicated the importance of the carboxyl group in radiolysis. A subsequent increase in temperature caused, together with destruction of the radicals, their conversion, which is related to migration of the free valence to the carboxyl group. The presence of oxygen at 77°K affected the radical yield in potassium palmitate and tripalmitin, but peroxide radicals formed in the three compounds only at higher temperatures. In potassium palmitate, an early stage of oxygen reaction with radicals was shown by their reverse disappearance in short-time contact. (tr-auth)

7571 RADIATION-INDUCED REDOX CONVERSIONS OF ACCEPTORS IN ORGANIC SOLVENTS. IV. CONVERSIONS OF TRI- AND HEXAVALENT CHROMIUM

COMPOUNDS IN ACETONE SOLUTIONS. M. Roder, N. A. Bakh, and L. T. Bugaenko (Moscow State Univ.). Kinetika i Kataliz, 5: 776-80(Sept.-Oct. 1964). (In Russian)

X rays acted on dilute solutions of CrO_3 and $CrCl_3$ in acetone to reduce the Cr(VI) to Cr(III) in both the absence and presence of oxygen. Yields were, respectively, 10.5 and 3.5 equivalents per 100 ev. Cr(III) was oxidized only in the presence of oxygen with a yield of 2.0 equivalents per 100 ev in 0.01M $CrCl_3$ solution. Cr(VI) in a complex with Cr(III) was more stable to the action of acetone radiolysis products than uncomplexed Cr(VI). (tr-auth)

7572 EPR AND MASS-SPECTROMETRIC INVESTIGATIONS OF LOW-TEMPERATURE RADIOLYSIS OF CERTAIN SIMPLE AROMATICS. G. K. Vasiliev and I. I. Chkheidze (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 802-6(Sept.-Oct. 1964). (In Russian)

Simultaneous EPR and mass-spectrometric studies showed considerably higher radical (G_R) yields than hydrogen (G_{H_2}) in low-temperature radiolysis of benzene, biphenyl, and some of their derivatives. Discrepancies in the G_R and G_{H_2} values for the compounds studied are explained by a secondary reaction of the hydrogen atoms, i.e., their addition to the double bonds in the ring, which is characteristic of aromatic compounds. (tr-auth)

7573 EPR INVESTIGATIONS OF IRRADIATED AMMONIUM PERCHLORATE. Yu. M. Boyarchuk, N. Ya. Buben, A. V. Dubovitskii, and G. B. Manelis (Inst. of Chemical Physics, Academy of Sciences, USSR). Kinetika i Kataliz, 5: 823-30(Sept.-Oct. 1964). (In Russian)

The nature, buildup, and recombination of paramagnetic centers formed by ionizing radiation in ammonium perchlorate, but pure and containing the additives CaO, MnO_2, and $KMnO_4$, were studied at 150 to 400°K. A similarity between the behavior of the radicals in irradiated and thermally decomposed NH_4ClO_4 was found. (tr-auth)

7574 REVERSIBLE PHOTOCHEMICAL BLEACHING IN FROZEN AQUEOUS SYSTEMS AT 77°K. P. N. Moorthy and J. J. Weiss (Univ. of Newcastle-upon-Tyne, Eng.). Nature, 204: 776-7(Nov. 21, 1964).

Phenomena related to coloration and bleaching of ice matrices containing sulfuric or phosphoric acid are examined. If these matrices are exposed to ionizing radiation, they become colored and upon exposure to heat or visible light become colorless. The mechanisms of these reactions are discussed. (J.R.D.)

7575 PRODUCTION OF BENZYL RADICALS BY IONIZING AND ULTRA-VIOLET RADIATION. B. Brocklehurst, G. Porter, and M. I. Savadatti (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 60: 2017-21(Nov. 1964).

The finding of Chilton and Porter, that photolysis of benzyl chloride and benzal chloride in rigid hydrocarbon solvents results in elimination of a chlorine atom whereas gamma radiolysis eliminates a hydrogen atom, was confirmed. In polar solvents, however, both photolysis and gamma radiolysis result in chlorine-atom elimination. The different primary processes responsible for these reactions are discussed. (auth)

7576 SOME CORRELATIONS OF AROMATIC DECOMPOSITION G VALUES. W. G. Burns (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Faraday Soc., 60: 2022-38(Nov. 1964).

A Ganguly-Magee diffusion model, with modifications, was set up for the production of hydrogen in the radiolysis of benzene; the experimental and theoretical dependence of $G(H_2)$ on the L.E.T. (linear energy transfer) of the radiation were correlated. The mechanism proposed is the interaction of two excited molecules in competition with collisional deactivation. For a range of values of the rate constants for deactivation and interaction, the position of the curve for the ratio of $G(H_2)$ for other radiations to that for electrons, as a function of $z(= (1/E_0)\int_0^{E_0}(-dE/dx)\,dE)$ depends only on r_0/ϵ, where r_0 is the spur radius and ϵ the energy per spur. For $\epsilon = 100$ ev, r_0 is 8–10 Å. The proportion of the initial active species in the track increases with L.E.T., and in the modified model there is a consequent decrease in the proportion of the unexcited deactivating species. The result is a lessened deactivating efficiency at high L.E.T., and a steeper rise in the predicted dependence of $G(H_2)$ on increasing L.E.T. The predicted curve is nearer the experimental curve than that obtained assuming no depletion of the deactivating molecules. An a priori calculation of $G(H_2)$ for BEPO pile neutrons, in reasonable agreement with experiment, was made by determining the energy distribution of hydrogen and carbon recoils from the neutron flux spectrum, taking $G(H_2)$ to be a function of z. Similar calculated values were found for $G(H_2)$ for the BEPO and OMRE reactors, although the mean neutron energies are very different. The closeness of the observed values of G(–M) for terphenyls in BEPO and OMRE, where M is the original molecule, is consistent with the similarity in the experimental curves of G(–M) for terphenyls and $G(H_2)$ for benzene against L.E.T. This similarity is thought to be due to a basic correspondence of mechanisms. (auth)

7577 KINETICS OF THE OXIDATION OF TETRAFLUOROETHYLENE BY MOLECULAR OXYGEN. D. Cordischi, M. Lenzi, and A. Mele (Comitato Nazionale per l'Energia Nucleare, Rome and Universita, Rome). Trans. Faraday Soc., 60: 2047-53(Nov. 1964).

The oxidation of tetrafluoroethylene induced by ionizing radiation gives carbonyl fluoride, tetrafluoroethylene oxide, perfluorocyclopropane, and a peroxidic liquid. The variations of rates of formation of these products with pressure of tetrafluoroethylene and oxygen and with dose-rate were investigated. The experimental results are in agreement with a kinetic scheme based on the formation of an intermediate of peroxidic character. (auth)

7578 CALORIMETRIC STUDY OF THE SOLID-PHASE RADIATION POLYMERIZATION OF ACRYLONITRILE. D. A. Kritskaya, I. K. Larin, A. N. Ponomarev, and V. L. Talrose (Inst. of Chemical Physics, Academy of Sciences, USSR). Vysokomolekul. Soedin., 6: 1944-51(Nov. 1964). (In Russian)

A calorimetric method was developed for studying low temperature radiation polymerization utilizing a beam of electrons with energies of several kilovolt. The method involves determination of the polymerization rate by measuring the heat evolved in a very thin reaction layer of the frozen polymer during irradiation and comparison of the value with the energy of the ionizing radiation absorbed in the layer. Application of the method on acrylonitrile (AN) has shown that polymerization of solid AN takes place directly in the irradiation process. The dependence of the radiation yield of the polymer G on the dose rate I was determined at 0.85 to 8.5 Mrad/sec. With increase in I, G diminishes from 120 acts for 100 ev at 0.85 Mrad/sec. to 50 at 8.5 Mrad/sec. The data show the possibility of extending the polymerization in the solid monomer beyond the region of irradiation. (auth)

7579 POLYMERIZATION OF DIALLYLSILANES UNDER THE ACTION OF γ-RAYS. L. E. Guselnikov, N. S. Nametkin, L. S. Polak, and T. I. Chernysheva (Inst. of Petroleum Chemical Synthesis, USSR). Vysokomolekul. Soedin., 6: 2002-7(Nov. 1964). (In Russian)

The γ-induced polymerization of a number of diallylsilanes according to the intramolecular-intermolecular mechanism was investigated. It was shown that under the influence of γ-radiation diallylsilanes polymerize with the formation of solid polymers with mp from 50 to 110°C, depending on the monomer structure. (auth)

7580 USE OF MÖSSBAUER EFFECT IN THE INVESTIGATION OF THE DIBUTYL TIN DIMALEATE BEHAVIOR AS STABILIZER IN IRRADIATION OF POLYETHYLENE. A. Yu. Aleksandrov, S. M. Berlyant, V. L. Karpov, S. S. Leshchenko, O. Yu. Okhlobystin, E. E. Finkel, and V. S. Shpinel. Vysokomolekul. Soedin., 6: 2105-7(Nov. 1964). (In Russian)

The γ-quantum resonance absorption spectra of dibutyltin dimaleate in polyethylene were obtained following irradiation of the system with Co^{60} γ-rays. It was found that in the course of the irradiation C–Sn bonds are predominantly cleaved, leading to the appearance of C_4H_9 free radicals.

On this basis a mechanism was proposed for the stabilizing action of organotin compounds in the irradiation of polyethylene. A study was also made of the dependence of the transformation of the stabilizer on the radiation rate. (auth)

7581 YIELD OF SOLVATED ELECTRONS FROM THE ACTION OF γ RADIATION AND OF He/Li PARTICLES ON ORGANIC GLASSES AT −196°C. J. Wendenburg and A. Henglein (Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Naturforsch., 19b: 995-8(Nov. 1964). (In German)

Glasses of methyltetrahydrofurane and of ethanol containing small amounts of triethylborate were irradiated with γ rays and with thermal neutrons. The yields of solvated electrons in the irradiated glasses were calculated from their optical absorption at 1200 and 540 mμ, respectively. $G(e^{\ominus}\ solv)$ was found to amount to 0.09 ± 0.04 and 0.14 ± 0.05, respectively, when He and Li particles from the nuclear reaction $^{10}B(n,\alpha)^{7}Li$ acted on the samples. $G(e^{\ominus}\ solv)$ for γ radiation was found by Hamill et al. to be equal to about 3.0 in both cases. Since the solvated electrons in both glasses are thermally very unstable, the heat produced in the track of a He or Li particle may in part be made responsible for the low yields of trapped electrons. (auth)

7582 REACTION BETWEEN PHOSPHORUS TRICHLORIDE AND CYCLOHEXENE UNDER THE INFLUENCE OF γ RADIATION AND HEAT. K. Wunder, H. Drawe, and A. Henglein (Hahn-Meitner-Institut fur Kernforschung, Berlin). Z. Naturforsch., 19b: 999-1005(Nov. 1964). (In German)

1-chlorocyclohexyl-phosphorus dichloride is formed in a Kharasch type chain reaction when γ rays act on mixtures of phosphorus trichloride and cyclohexene. The G-value is proportional to the reciprocal square root of the dose rate and reaches a maximum at 100°C The activation energy of the rate determining step $PCl_2C_6H_{10} + PCl_3 \rightarrow PCl_3C_6H_{10}Cl + PCl_2$ was found to amount to 6.7 kcal/mole. At higher temperatures, the yield decreased strongly since another chain reaction predominated, which produced cyclohexyl-phosphorus dichloride. The two chains had a common propagation step. 1-chlorocyclohexyl-phosphorus dichloride and cyclohexyl-phosphorus dichloride were also thermally formed at temperatures above about 150°C. (auth)

7583 RADIOLYSIS OF CARBON DISULFIDE AND DOSIMETRY WITH CS_2 VAPOR. O. Janssen, A. Henglein, and D. Perner (Hahn-Meitner-Institut für Kernforschung, Berlin and Mellon Inst., Pittsburgh). Z. Naturforsch., 19b: 1005-14(Nov. 1964). (In German)

A polymer and free sulfur are formed in carbon disulfide under the influence of ionizing radiation. The polymer has the summary formula $(CS)_n$ when it is formed in liquid CS_2 at 150°C. Its composition is close to $(CS_2)_n$ if it is produced in liquid CS_2 at −84°C or CS_2-gas at 23°C. $G(-CS_2)$ depended strongly on the phase: <0.01 in the solid state (−185°C), 0.8 at 27°C, 1.3 at −84°C in the liquid, and 15.4 in the gas (23°C). $G(-CS_2)$ in the gas was independent of dose, dose rate, CS_2-pressure, and kind of radiation (γ, electrons, protons). A gas-phase dosimeter is described, which allows the absorbed dose to be determined by simple manometric measurement. The energy required to produce an ion pair in CS_2-vapor was found to be equal to 26.5 ev. Dissolved sulfur retarded the decomposition of liquid CS_2. Dissolved iodine and DPPH were consumed. Much higher concentrations of these solutes were required to scavenge all intermediate products than in hydrocarbons. At low solute concentrations, no dependence of yield on dose rate could be observed. It seemed therefore that these solutes reacted with intermediates in the spurs. The iodine consumed was incorporated into the polymer. Polymers with iodine contents up to 60 wt % were obtained. (auth)

7584 GAMMA RADIOLYSIS OF FURANS AND THIOPHENES. A. Granzow, J. Wendenburg, and A. Henglein (Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Naturforsch., 19b: 1015-17(Nov. 1964). (In German)

Liquid furan and thiophene were decomposed by γ rays with total G-values of 7.0 and 3.2, respectively. The main products were polymers, which had the initial elementary composition, olefinic double bonds and CO-groups (in furan). Gaseous products such as hydrogen, acetylene, propylene, and carbon monoxide were formed with 100-ev yields below unity. The results were compared with the known radiolysis of liquid benzene. (auth)

7585 THEORY OF MOLECULAR TRANSFORMATIONS INDUCED BY NEUTRONS. G. K. Ivanov and Yu. S. Sayasov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1405-14(Oct. 1964). (In Russian)

A general method is developed for investigating the probabilities of molecular transformations induced by neutron impact. The method is based on an application of the impulse approximation to secondary collisions between atoms ejected by the neutrons and other atoms of the molecule. The method is employed for calculating the probability of dissociation of triatomic molecules by neutrons with concurrent excitation of the diatomic residue. (auth)

7586 PHOTOINACTIVATION OF TRYPSIN AS SENSITIZED BY FLAVINS, METHYLENE BLUE AND EOSIN Y. Camillo Angelo Ghiron. Thesis, Salt Lake City, Univ. of Utah, 1964. 169p.

The kinetics of the dye-sensitized photoinactivation of the enzyme trypsin were examined in relation to various proposed mechanisms using flavins, methylene blue, and eosin Y as sensitizer dyes. The effects of variables such as enzyme concentration, dye concentration, pH dependence, light intensity, etc., on the kinetics of inactivation of trypsin were analyzed. Some experiments were also done using the enzyme ribonuclease. Parallel measurements of the changes in absorption of the dyes during the reaction were made. In some cases the reaction was also followed by measuring the amount of oxygen consumed using standard manometric techniques. The time-course of the dye-sensitized photoinactivation of trypsin was found to be first-order. Some photobleaching of the dyes was observed during the photodynamic reaction. The ratio of the initial rate of oxygen consumption to the initial rate of trypsin inactivation on illumination was found to vary greatly with the sensitizer dye used. It is concluded that the mechanism of the photodynamic reaction is different for each of the three sensitizers. The kinetics of the dye-sensitized photoinactivation of trypsin were compared with the four main types of mechanisms proposed to explain photodynamic action. The present results do not conform to any one of the several mechanisms proposed. It is therefore concluded that photodynamic action is probably a class of reactions, the mechanism depending on the reaction conditions and on the sensitizer dye used. In addition to the kinetic studies, the trypsin inactivation products were analyzed using the method of disc electrophoresis with columns of polyacrylamide gel and, further, by various other biochemical tests. (A.G.W.)

7587 RECOIL TRITIUM REACTIONS WITH CYCLIC C_6 HYDROCARBONS. John Kenneth Garland. Thesis, Lawrence, Kan., Univ. of Kansas, 1963. 203p.

Highly energetic atoms of tritium are produced by nuclear reactions and allowed to react with hydrocarbons present in the systems. The hydrocarbons studied include cyclohexane, cyclohexene, 1,4-cyclohexadiene, and benzene, singly, in gas and liquid phases. In addition, the following two-hydrocarbon systems were studied: ethylene plus each of the above mentioned hydrocarbons, cyclohexane plus propylene, and benzene plus methane, isobutane, acetylene, propylene, and cyclohexane. Tritium-labeled products were separated and counted by gas chromatography in series with a flow proportional counter. In the liquid samples this technique proved inadequate for full recovery of all the tritium produced. An auxiliary analysis involving flow reversal chromatography, solvent extraction, and combustion of residues was successful in recovering the remainder of the tritium and gave a crude separation of long chain polymers from short chain polymers. On the basis of the data obtained, reaction models are proposed for the reactions of energetic hydrogen atoms with each of the cyclic C_6 hydrocarbons studied. In addition, a group of related experiments by Nesmeyanov and coworkers, done with a less complete analysis of products, is reevaluated in the light of the new data. Ar-

guments are presented in favor of a series of new and different explanations of these related experiments, and the results are compared and correlated with the data and proposed reaction models of this thesis. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7588 ENERGY MIGRATION IN RARE EARTH COMPLEXES. John Jerome Freeman. Thesis, Albuquerque, N. Mex., Univ. of New Mexico, 1964. 217p.

Complexes of trivalent samarium, europium, terbium, and dysprosium were prepared for investigations of the luminescence properties of complexed rare earth ions. Rare earth chelates derived from benzoylacetone, dibenzoylmethane, and acetylacetone rare earth chlorides solvated with water and deuterium oxide, and rare earth oxides dissolved in sodium metaphosphate glasses were synthesized for these studies. The visible absorption spectra of solutions of rare earth chelates and rare earth chlorides are presented and analyzed. Rare earth ion radiative transition probabilities, calculated from the weak ion absorption bands, are reported. The luminescence investigations were also carried out on microcrystalline chelates, crystalline solvated chlorides, and metaphosphate glasses. The emission spectra are presented and J–J assignments are made. Measurements of spectral lines arising from vibronic coupling of chelated rare earth ions are given. The luminescence decay curves of the complexes are reported, and decay times calculated from the curves are tabulated. For a few of the samples, the temperature dependencies of the luminescences are also reported. Quite significant differences were found in the luminescence intensities and decay times of rare earth ions in different environments. Possible mechanisms for quenching of rare earth ion states are presented, and it is concluded that the variations of the luminescence properties of the ions are due to variations in vibronic quenching efficiency. The nature of the vibronic quenching in each of the different rare earth complex systems is discussed. Secondary environmental effects on the rare earth ion luminescences are considered. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7589 ENERGY TRANSFER AND QUENCHING IN PLASTIC SCINTILLATORS. Fumio Hirayama. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 296p.

In Part I, the fluorescence spectrum of polystyrene was investigated both in solid phase and in liquid solution. Also measured were fluorescence spectra of related compounds. Fluorescence of bulk thermally polymerized polystyrene is almost entirely that emitted from residual styrene monomer. The fluorescence spectrum of pure polystyrene, free of residual monomer, is a structureless band with maximum at 328 mμ and half-width 50 mμ. The spectrum of polystyrene in solution consists of two bands –a smaller band at about 280 mμ (S band), and a larger structureless band with maximum at 333 mμ (P band). Relative intensities of S band and P band are dependent on the kind of solvent. It is concluded that an electronically excited segment of polystyrene interacts with an unexcited segment to form an excited associate, or an "excimer," and that the emission from these excimers is responsible for fluorescence of solid polystyrene and P band fluorescence of the solution; S band fluorescence is the emission from unassociated segments. In Part II, luminescence quenching in plastic scintillators was studied on two plastic systems: 1) polystyrene +9,10-diphenylanthracene + quencher, and 2) polystyrene + quencher. In the latter system, residual styrene monomer was treated as the fluorescent solute. Absorption and fluorescence spectra, light output under ultraviolet and beta ray excitation, and fluorescence decay times under pulsed electron excitation were measured. The solvent and solute quenching constants, α and β, respectively, are determined from the experimental data. Also, these constants are calculated theoretically from the optical data of individual components of the samples. Luminescence quenching under beta-ray excitation was generally greater than under uv excitation. Observed solute quenching in some series of polystyrene +9,10-diphenylanthracene + quencher is not accounted for by usual mechanisms of quenching. Such quenching can be explained qualitatively by assuming the energy transfer from the singlet excited state of 9,10-diphenylanthracene to the triplet state of the quencher. (A.G.W.)

7590 ELECTRON SPIN RESONANCE OF IRRADIATED KH_2PO_4 AND KD_2PO_4. William Eugene Hughes. Thesis, Tuscaloosa, Ala., Univ. of Alabama, 1963. 53p.

Electron spin resonance of electron- and x-irradiated single crystals of KH_2PO_4 and KD_2PO_4 was studied. Irradiation produces free radicals, which appear to be stable at 77°K but decay rapidly above about 140°K. The spectra can be interpreted as an isotropic hyperfine coupling to the ^{31}P nucleus with about 0.9% 3s spin density on the phosphorus and the rest in a p-orbital on the oxygen. The g tensor is calculated for KD_2PO_4, and it is highly anisotropic. The model predicted is a $HO_3PO \cdot$ radical for KH_2PO_4 or a $DO_3PO \cdot$ radical for KD_2PO_4. An almost isotropic doublet predominates in the high energy irradiated KD_2PO_4 samples, and it is proposed that this doublet is due to a second kind of center. (Dissertation Abstr., 25: No. 3, Sept. 1964)

7591 STUDIES OF RADIATION POLYMERIZATION OF LIQUID VINYL CHLORIDE UNDER THE ACTION OF X RAYS AND OF SOME PROPERTIES OF RADIATION POLYMERIZED VINYL CHLORIDE. H. Behrens. Thesis, Leipzig, Universität, 1964. 100p. $2.00(Gmelin, AED-DISS. 64-102). (In German)

The influence of oxygen, temperature, and radiation quality and intensity on the polymerization of vinyl chloride and on the properties of the product was studied. A polymer of high internal order was obtained by short time irradiation. Radiation polymerized poly(vinyl chloride) has a syndiotactic structure. (Gmelin Inst.)

7592 IRRADIATION OF BITUMINOUS MATERIALS. Clyde D. Watson and W. W. Parkinson (Oak Ridge National Lab., Tenn.). p.289-321 of "Bituminous Materials: Asphalts, Tars, Pitches." New York, Interscience Publishers, 1964.

The effects of radiation on asphalts and coal tar pitches and estimations of some of the uses of asphalts in the presence of radiation are discussed. The effects of ionizing radiation on organic materials are reviewed. It was found that gamma irradiation of asphalts causes: evolution of H_2 and CO_2, resulting in an increase in volume and a honeycomb structure; an increase in softening point; a slight but insignificant change in ductility; a decrease in penetration; a decrease in flash point but no increase in "loss-on-heating"; and an increase in asphaltenes and a decrease in oils. Data are presented in tables and graphs. The addition of rubber or mineral fillers was not beneficial. Asphaltic membranes, prefabricated asphaltic membrane, and plank samples were still serviceable after 10^9 R irradiation. Irradiated coal tar pitches were also serviceable. It was concluded that, in general, asphalts and tars can be used successfully in radiation environments as long as the total exposure does not exceed 10^9 R. Asphaltic membranes appeared practical as a lining for emergency or permanent earth basins to contain low-level radioactive solutions. (M.C.G.)

7593 SrY-90 BETA IRRADIATOR DESIGN FOR USE IN CHEMICAL PROCESSING. T. N. Lahr and J. J. Keers (Minnesota Mining and Mfg. Co., St. Paul). 11p. (CONF-571-19)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Description is given of a ^{90}Sr-Y beta irradiator for use in the radiation processing of liquid or gaseous product streams. The device has small size, low weight, and flexibility and would seem to have great utility in pilot production or the laboratory evaluation of polymerizations or other reactions that can be carried out in the liquid or gaseous state. (P.C.H.)

7594 PROPAGATION MECHANISM IN RADIATION-INDUCED IONIC POLYMERIZATION. D. O. Geymer (Shell Development Co., Emeryville, Calif.). 17p. (CONF-571-18)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Isobutylene and butadiene were copolymerized at −78° by ionizing radiation. The composition of the copolymer was determined by the monomer reactivity ratios r_1 (butadiene) = 1.0 and r_2 = 8. Rates of polymerization and molecular weights passed through a minimum as the composition of the feed was varied from pure isobutylene to pure butadiene. The presence of zinc oxide during irradiation strongly accelerated the rate of copolymerization and enhanced the molecular weight. The monomer reactivity ratios in this case were approximately r_1 = 1.2 and r_2 = 14. Since zinc oxide influences the composition of the copolymer and, therefore, the relative speed of the propagation reactions, it was concluded that the propagating carbonium ion is associated with the surface of the zinc oxide. (P.C.H.)

7595 HIGH DENSITY, SOFT PHOSPHATE GLASS, METHOD, AND GAMMA RADIATION SHIELDING WINDOW. Harrison P. Hood and Thomas C. MacAvoy (to Corning Glass Works). U. S. Patent 3,149,234. Sept. 15, 1964. Filed Oct. 27, 1959.

Methods of preparing phosphate glasses and their properties for use as radiation shielding windows are described. The glass is transparent and does not darken on exposure to high levels of short-wave radiation. It has a density of at least 2.5 and a viscosity at room temperature (25°C) of at least 10^4 poise. The glass does not accumulate electric charge when subjected to high levels of irradiation. It is composed of 26 to 51 mole % P_2O_5, 33 to 56 mole % H_2O, and 12 to 26 mole % of an oxide of Rb, Hg, or Tl, and 0 to 5 mole % of optional glass-making metallic oxides selected from Al, Ba, Th, Cs, Bi, K, Sn, or Zn oxides. (M.C.G.)

Radiochemistry

7596 (IA-986) RECOVERY OF AMERICIUM AND CURIUM FROM AN IRRADIATED PLUTONIUM "NAPKIN-RING." I. THE PROPOSED PROCESS. M. Givon and M. Zangen (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Oct. 1964. 10p. Dep.(mn).

A process is proposed for recovering Am and Cm from an irradiated Pu "napkin-ring." It involves the use of the Junior Cave of the Hot Laboratory. The necessary equipment and the proposed procedure are described. Some novel features, not used in previous recovery processes, are discussed. (auth)

7597 LIQUID SCINTILLATION COUNTING ERRORS DUE TO OXYGEN-QUENCHING OF SAMPLES PREPARED BY THE OXYGEN-FLASK COMBUSTION PROCEDURE. W. D. Conway and A. J. Grace (Sterling-Winthrop Research Inst., Rensselaer, N. Y.). Anal. Biochem., 9: 487-9(Dec. 1964).

Data are given supporting an explanation for liquid scintillation counting errors due to oxygen-quenching of samples prepared by the oxygen-flask combustion procedure. Two methods found for equilibrating the counting samples with air are described. (P.C.H.)

7598 COLLOIDAL CHROMIUM PHOSPHATES WITH PHOSPHORUS-32. Manuel Angoso Marina (Junta de Energia Nuclear, [Madrid]). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 381-90(May 1964). (In Spanish)

A critical study was made of the results obtained when Anghileri's and Chevalier's methods are applied, and a different procedure for the preparation of colloidal chromium phosphate label with ^{32}P is described. In relation to Anghileri's method it is shown that it leads to colloids with a size between 600 and 200 Å, depending on the gelatin concentration. These colloids flocculate when they are sterilized by heating. The method given by Chevalier is shown to give products which also flocculate when they are sterilized by heating. The procedure developed consists of simple precipitation and allows preparation of a colloid with higher stability that may be sterilized by heating in an autoclave. Because of its size (350 to 222 Å) this colloid may be applied in intracavitary injections, as tests conducted in rats have shown. Size determination and assay of the degree of dispersion were carried out by centrifugation. (auth)

7599 COLLOIDAL ZIRCONYL PHOSPHATES WITH PHOSPHORUS-32. Manuel Angoso Marina (Junta de Energia Nuclear, [Madrid]). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 60: 391-7(May 1964). (In Spanish)

A method for the direct preparation of colloidal zirconyl phosphate labeled with ^{32}P is described; the radioactive yield attained was higher than 99%; the size of the colloidal particles, as determined by centrifugation, was 300 Å; this size could be varied by modifying the gelatin or ZrO^{2+} concentrations. The stability of these colloids depended essentially on the concentration of ZrO^{2+} ions and of gelatin; the concentration limits within which the colloids are stable, were established. The colloids were sterilizable by heating in an autoclave. (auth)

7600 THE EFFECT OF γ-RADIATION ON URANYL COMPOUNDS IN ORGANIC SOLVENTS. I. REDUCTION OF URANYL NITRATE IN TRIBUTYL PHOSPHATE. J. Dziegielewski, J. Kalecinski, and B. Jezowska-Trzebiatowska (Univ. Wroclaw, Poland and Inst. of Structural Research, Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 537-44(1964).

Kinetics of the gamma radiolysis of uranyl nitrate in TBP were studied. The absorption spectra of the irradiated solutions underwent a characteristic change. Initially, extinction in the 340 to 450 mμ range increased with time of irradiation, but during further irradiation it decreased. U(VI) reduction yields were calculated. Rate equations are given. (M.C.G.)

7601 THE EFFECT OF γ-RADIATION ON URANYL COMPOUNDS IN ORGANIC SOLVENTS. II. REDUCTION OF URANYL CHLORIDE IN TRIBUTYL PHOSPHATE. J. Dziegielewski, J. Kalecinski, and B. Jezowska-Trzebiatowska (Univ. Wroclaw, Poland and Inst. of Structural Research, Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci. Chim., 12: 545-9(1964).

The radioinduced reduction of uranyl chloride in TBP solutions was studied and the yield of radicals directly reducing U(VI) was determined. The absorption spectra changed under the influence of gamma radiation. At first, a slight increase of extinction at 370 to 440 mμ was observed and continued irradiation resulted in extinction decrease in this band. Simultaneously a practically complete precipitation of U(VI) occurred in the form of mono- and dibutyl phosphates. (M.C.G.)

7602 A STRUCTURAL TRANSFORMATION OF CURIUM SESQUIOXIDE. J. C. Wallmann (Univ. of California, Berkeley and Centre d'Etudes Nucléaires, Fontenay-aux-Roses, France). J. Inorg. Nucl. Chem., 26: 2053-7 (Dec. 1964).

An additional structure for Cm_2O_3 is reported. Cubic Cm_2O_3 was produced by hydrogen reduction of a higher curium oxide and found to transform spontaneously after several weeks to hexagonal Cm_2O_3, of La_2O_3 type structure. The hexagonal structure has lattice parameters of a = 3.80 ± 0.02 and c = 6.00 ± 0.03 Å and presumably results from radiation damage effects in the crystal lattice. (auth)

7603 ON THE REACTION OF PROTACTINIUM PENTOXIDE WITH SOME OXIDES OF TRIVALENT ELEMENTS. C. Keller (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 26: 2069-74(Dec. 1964). (In German)

The reaction of Pa_2O_5 with rare earth oxides yielded ternary oxides $(Me^{III}_{0.5}, Pa^{V}_{0.5})O_2$ with fluorite structure and statistical distribution of the heavy metal ions. It was concluded that there is probably a (III-V) – (IV-IV) valence exchange in $(Ce_{0.5}, Pa_{0.5})O_2$. The system $(Ce_{0.5}, Pa_{0.5})O_2$ showed complete solid solutions with CeO_2. There was no reaction in the systems Pa_2O_5/Me_2O_3 (Me = Cr, Al, Fe, V, Rh). Only Ga_2O_3 reacted with Pa_2O_5 to form $GaPaO_4$. (auth)

7604 DEPOSITION OF VARIOUS RADIOACTIVE ELEMENTS ON THE SURFACE OF A PLATINUM ANODE. II. ON THE ACTIVATION ENERGY OF THE ANODIC DEPOSITION OF RADIOACTIVE ELEMENTS. I. Mádi (Kossuth Univ., Debrecen, Hungary). J. Inorg. Nucl. Chem., 26: 2135-47(Dec. 1964).

The kinetics of the anodic deposition of ^{144}Ce was studied as a function of anode voltage and temperature. The extent of deposition was investigated at fixed anode voltage at various temperatures and the value of the activation energy was determined for a given voltage from the temperature dependence of the rate constants. The voltage dependence of the activation energies was found from measurements at different voltages. (auth)

7605 DEPOSITION OF VARIOUS RADIOACTIVE ELEMENTS ON THE SURFACE OF A PLATINUM ANODE. III. THE NUMBER OF ACTIVE CENTERS AS A FUNCTION OF THE ANODE VOLTAGE AND THE TEMPERATURE. I. Mádi (Kossuth Univ., Debrecen, Hungary). J. Inorg. Nucl. Chem., 26: 2149-57(Dec. 1964).

The change of the equilibrium distribution coefficient, which characterizes the anodic deposition of ^{144}Ce with increasing $Ce_2(SO_4)_3$ concentration was investigated. The Langmuir isotherm could be applied to the deposition data. The experimental data showed that the number of active centers, which is a characteristic of the anodic deposition, depends on the anode voltage and, at constant voltage, on the temperature. The activation energy for a given voltage was determined from the temperature dependence of the number of active centers. The voltage dependence of the activation energy for deposition was studied by the evaluation of isotherms obtained for several voltages at different temperatures. (auth)

7606 THE THERMAL DECOMPOSITION OF THE COMPLEX FORMED IN THE URANIUM(VI)–SULPHURIC ACID–TRI-n-DODECYLAMINE EXTRACTION SYSTEM. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 26: 2229-34(Dec. 1964).

The complex formed in the extraction of uranium(VI) from sulfuric acid solution by tri-n-dodecylamine in benzene was freed from benzene by vacuum evaporation prior to thermogravimetric examination and differential thermal analysis. The complex and its thermal decomposition products were examined by infrared spectroscopy. A structure is proposed for the complex. (auth)

7607 RAPID SEPARATION AND HOT ATOM CHEMISTRY OF NITROGEN ISOTOPES. S. Amiel and E. Yellin (Israel Atomic Energy Commission, Yavne). J. Inorg. Nucl. Chem., 26: 2285-8(Dec. 1964).

Nitrogen isotopes produced from fast neutron reaction with oxygen and the chemical fate of the recoils were studied. The instantaneous production of nitrogen oxides by the recoiling of nitrogen from (n,p) reactions with oxygen was used as the basis for separation of these isotopes from any other radionuclides produced in the irradiation. The difference in boiling and melting points between oxygen gas and the nitrogen oxides was used to separate the nitrogen oxides from the gas flow. It was concluded that, on interaction with gaseous O_2, hot ^{16}N atoms form NO and not NO_2. Nitrogen molecules containing one ^{16}N atom are also formed if nitrogen is present in the gas. (M.C.G.)

7608 A CADMIUM URANATE Cd_2UO_5. M. Sterns and J. O. Sawyer (Australian National Univ., Canberra). J. Inorg. Nucl. Chem., 26: 2291-6(Dec. 1964).

The compound Cd_2UO_5 was formed in the solid-state reaction of CdO with U_3O_8. Examination by x-ray-diffraction methods showed that it is structurally related to the corresponding calcium and strontium uranates. The composition was confirmed by direct chemical analysis. (M.C.G.)

7609 MASS SPECTROMETRY-KNUDSEN CELL STUDIES OF THE VAPORIZATION OF URANIUM DICARBIDE. J. H. Norman and P. Winchell (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Phys. Chem., 68: 3802-5(Dec. 1964).

The presence of $UC_2(g)$ was found to be important in the vaporization of uranium dicarbide. In the presence of excess carbon, the vaporization of uranium dicarbide as $UC_2(g)$ can be represented by a heat of vaporization of 185 kcal/mole and an entropy of 38.3 cal/°K mole in the temperature range from 2350 to 2700°K. Good thermodynamic agreement between this work and previous studies of vaporization of uranium dicarbide to U(g) + 2C(s) was obtained. The values obtained in this study were $\Delta H = 127.3$ kcal/mole and $\Delta S = 18.6$ cal/°K mole in the temperature range from 2150 to 2700°K. (auth)

7610 PREPARATION OF COLLOIDAL RADIOACTIVE YTTRIUM SILICATE. N. B. Mikheev, M. El-Garhy, and R. Azzam (Atomic Energy Establishment, Cairo). Kernenergie, 7: 712-13(Oct. 1964). (In German)

The production of stable negatively charged colloidal yttrium silicate is described. By using radiometric titration the composition of the silicate is determined to be $Y_2(Si_2O_5)_3 \cdot nH_2O$. (auth)

7611 SOME RADIOCHEMICAL BEHAVIOURS OF RADIOACTIVE IRON. PART I. Tomihisa Kambara, Kunihiko Hasegawa, Masayuki Ishikawa, and Masahiko Urata (Shizuoka Univ., [Japan]). Radioisotopes (Tokyo), 13: 444-9 (Nov. 1964).

The $^{59}Fe(III)$ dissolved in sulfuric acid solution was reduced with the zinc amalgam reduction method. The reduction yields for several conditions were investigated. It was found that the effects of sulfuric acid concentrations on these yields were not so remarkable as compared with those of Fe(II) carrier concentrations. The $^{59}Fe(II)$ thus obtained was kept for standing at 25°C and the per cent decreases of $^{59}Fe(II)$ were measured with the lapse of the reaction time. From all the experiments linear relations were obtained by plotting the logarithms of the per cent of $^{59}Fe(II)$ remained versus the time elapsed. The effects of the sulfuric acid concentrations, the specific activity concentrations, and chloride ion concentrations were investigated. The conversion mechanisms of $^{59}Fe(II)$ to $^{59}Fe(III)$ were concluded to depend upon the radiation induced electron exchange process. (auth)

7612 Sc^{47} MEASUREMENTS IN SAMPLES CONTAINING Ca^{47} AND Sc^{47}. B. Gwiazdowska and J. Nowosielski. p.3-5 of STI/DOC/10/32.

A method for measuring ^{47}Sc in the presence of ^{47}Ca using a 2-in. diameter by 1½ in. NaCl(Tl) crystal and pulse-height spectrometer is presented and evaluated. (H.M.G.)

Separation Processes and Procedures

7613 (BLG-267) THE USE OF INORGANIC ION EXCHANGERS IN ACID MEDIUM FOR THE RECOVERY OF Cs AND Sr FROM REPROCESSING SOLUTIONS. L. Baetsle, D. Van Deyck, D. Huys, and A. Guery (Centre d'Étude de l'Energie Nucléaire, Brussels). Aug. 1964. 14p. Dep. (mn).

Among the many existing separation techniques, ion exchange on mineral ion exchangers seems to be the most promising one for the quantitative separation of long-lived fission products from acid reprocessing solutions. Zirconium phosphate (ZrP) is suitable for the separation of ^{137}Cs from reprocessing solutions desacidulated to 0.5 M HNO_3. The specific activity amounts to 0.5 to 1 Ci/g ZrP when the feed solution contains 20 Ci/l. Ferrocyanide molybdate (FeMo), a new mineral ion exchanger, allows the selective ^{137}Cs separation from reprocessing solutions after their desacidulation to 2 M HNO_3 by formaldehyde. The loading capacity for ^{137}Cs amounts to 2 to 4 Ci/g FeMo. A new Sr-selective ion exchanger, called polyantimonic acid, was developed and showed to be indicated for the ^{90}Sr recovery from acid reprocessing effluents. (auth)

7614 (DP-896) ELECTROLYTIC DISSOLVER FOR POWER FUELS. Vincent P. Caracciolo and Albert A. Kishbaugh (Du Pont de Nemours (E. I.) & Co. Savannah

River Lab., Aiken, S. C.). Oct. 1964. Contract AT(07-2)-1. 32p. Dep.; $2.00(OTS).

A 5000-ampere electrolytic dissolver was built and successfully operated with unirradiated fuel assemblies. Practical rates of dissolution were obtained with fuel assemblies of UO_2 clad in stainless steel or Zircaloy; UO_2–stainless steel cermet plates clad in stainless steel; and stainless steel-clad, sodium-bonded uranium rods. (auth)

7615 (HW-83550) A STUDY OF TUNGSTEN–TECHNETIUM ALLOYS. Quarterly Progress Report, April 1, 1964–July 1, 1964. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 14, 1964. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Technetium was prepared from fission product technetium-99 isolated from Purex plant waste solutions. The isolation of the technetium was made in four stages which includes two anion exchange cycles followed by preparation of pure ammonium pertechnetate and reduction of ammonium pertechnetate to metal in a hydrogen furnace. (N.W.R.)

7616 (NP-14587) CONCEPTION OF THE EUROCHEMIC REPROCESSING INSTALLATION. T. J. Barendret, et al. (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). July 1964. 45p. Dep.(mn). (In French and English)

A description is given of the design concept of the Eurochemic facility for the reprocessing of a wide variety of fuel elements of natural or high enrichment U. Site layout, time schedule, and building layouts are given. The chemical process to be used is described. Nuclear safety means are considered together with control and instrumentation. The investment of the plant is summarized. (D.L.C.)

7617 (ORNL-3697(p.49-53)) MINERAL EXCHANGE STUDIES. Tsuneo Tamura, D. G. Jacobs, Tohru Murano, and W. P. Bonner (Oak Ridge National Lab., Tenn.).

In sorbing trace concentrations of strontium, ideal ion exchange behavior, based on mass action expressions, was exhibited by several of the clay minerals under special conditions. Hydrous sesquioxides sorbed strontium preferentially, and the strontium sorption curve did not yield the predicted slope for ideal behavior. Conasauga shale was shown to behave according to the mass action law when the free iron oxide was removed. Ethylenediaminetetraacetate (EDTA) forms a more stable complex with calcium than with strontium. In a waste solution containing calcium as a major ionic component, the major break-through of strontium through an ion exchange column can be delayed by complexing part of the calcium with EDTA. However, the delayed break-through of strontium is gained at the expense of increased leakage of strontium through the ion exchange column. (auth)

7618 (ORNL-TM-995) DEVELOPMENT OF AN AIR-OPERATED, METAL-DIAPHRAGM PUMP FOR THE TRANSURANIUM PROCESSING FACILITY. T. S. Mackey (Oak Ridge National Lab., Tenn.). Oct. 16, 1964. Contract [W-7405-eng-26]. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The TRU sampler and process pump was tested under similated operating conditions. The results demonstrate the feasibility of the design and the requirements that must be met for successful operation and maintenance. Information was determined and reported on the pump design, diaphragm seal configuration, diaphragm life, and operating procedures. (auth)

7619 (RT/CHI(64)-7) THE EUREX PLANT INSTRUMENTATION AND CONTROL. G. Calleri and L. Mannucci (Italy. Comitato Nazionale Energia Nucleare, Rome). Apr. 1964. 25p. Dep.(mn).

A review of the instrumentation and control system proposed for the Eurex plant is given. Interest is focused on the general philosophy adopted for the process instrumentation including a short description of the main process circuits. Also given is a short review of the heat and ventilation system, the nuclear instrumentation and control system; some of the most important circuits are described in detail. (auth)

7620 (TID-21411) ION EXCHANGE SEPARATION OF URANIUM AND THORIUM IN NON-AQUEOUS AND MIXED MEDIA. Progress Report, May 1964–October 1964. Johann Korkisch (Vienna. Universität. Analytisches Institut). Oct. 1964. Contract AT(30-1)-2623. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Two applications of anion exchange in mixed- and non-aqueous solvents as well as one study of the adsorption behavior of uranium in mixed organic solvents are described. One application concerns the determination of uranium in ferrous alloys after preliminary separation of uranium from interfering elements such as iron, cobalt, etc. by anion exchange in a methyl glycol–hydrochloric acid system. Due to the effectiveness of this method for the assay of uranium in steels it will also be applicable on a more general basis for the analysis of other materials with high iron content such as iron meteorites, coal ashes, etc. without preceding solvent extraction of iron chloride. This procedure is thus well suited to replace solvent extraction whenever great amounts of iron have to be separated from uranium or other metals which show similar behavior, such as cobalt, copper, lead, etc. Consequently the use of this method can further be extended for the isolation and determination of these elements in various materials as for instance in minerals, rocks, and marine sediments. The other application is dealing with the anion exchange separation of large amounts of uranium from small quantities of beryllium, vanadium, and other elements using a nitric acid–methanol medium. This method may be of importance in connection with the determination of beryllium in uranium used as a reactor fuel, and of vanadium in uranium compounds obtained in the processing of uraniferous materials such as carnotite ores. Further the anion exchange behavior of uranium in mixed aqueous and non-aqueous systems consisting of various aliphatic alcohols and mineral acids was investigated. (auth)

7621 (ORNL-tr-301) PARTITION CHROMATOGRAPHY ON AN ION EXCHANGE RESIN. II. THE SEPARATION OF Rh, Pd, Ir, AND Pt. L. N. Moskvin and B. K. Preobrazhenskii. Translated by S. J. Rimshaw and Joe F. Allen (Oak Ridge National Lab., Tenn.), from Radiokhimiya, 6: 237-41(1964). 11p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

A chromatographic separation scheme for Pd, Rh, Pt, and Ir was developed using an ion-exchange resin as the carrier of the aqueous phase. The separation of the platinum metals was studied in the acetylacetone–HCl system and the n-hexyl alcohol–HCl system. (auth)

7622 INORGANIC ION EXCHANGERS. II. SORPTION RATE AND DEHYDRATION STUDIES ON ZIRCONIUM PHOSPHATE AND TUNGSTATE GELS. Sten Ahrland, Joergen Albertsson, Lars Johansson, Bengt Nihlgard, and Lennart Nilsson (Univ. of Lund, Sweden). Acta Chem. Scand., 18: 1357-67(1964).

The sorption rates of metal ions on zirconium phosphate gels depend on the composition of the gels, characterized by the ratio phosphate/zirconium, $(P/Zr)_s$, and the water content. If these quantities are chosen high enough, most ions can be sorbed at a quite satisfactory rate. The values needed in order to achieve this vary considerably, however, between different ions, being much lower e.g. for Cs^+ and Sr^{2+} than for UO_2^{2+}. For a gel with a ratio $(P/Zr)_s$ close to the upper limit of 2, a dehydration below approximately 1.5 mole of water per zirconium atom brings about a rapid decrease in the sorption of Sr^{2+} at equilibrium, indicating a rather sudden break-down of the ion exchange properties of the gel as the water content falls below the mentioned value. An ignited gel, i.e. the water-free pyrophosphate, sorbs less than one tenth of the Sr^{2+} sorbed by a gel containing an appropriate amount of water. Determinations of the water still held at equilibrium by the same gel of $(P/Zr)_s \approx 2$, as the temperature is increased, show that one mole of water per zirconium atom is held much more firmly than the rest. This final mole of water stems from the phosphate groups. They must therefore be monohy-

drogen groups, which are compatible with the behavior of the gel on neutralization, and also with the layer structure proposed for zirconium phosphates. For zirconium tungstate gels, the sorption properties depend on the value of pH prevailing at their precipitation, as was found in experiments with UO_2^{2+}. This was not unexpected, considering the different composition of the polytungstate ions dominating in solutions of various pH. (auth)

7623 A RAPID RADIOCHEMICAL METHOD FOR ANTIMONY AND ARSENIC. PART I. FORMATION OF STIBINE AND ARSINE BY FLASH ELECTROLYSIS. L. Tomlinson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Anal. Chim. Acta, 31: 545-51 (Dec. 1964).

The formation of stibine and arsine affords a clean, one-step, method of separating antimony and arsenic from fission products. The development of a high-current electrolytic cell for the rapid formation of these hydrides from a hydrochloric acid electrolyte, is described. A chemical yield of 45% was achieved for both antimony and arsenic in 10 sec. The effects of pH and antimony and arsenic oxidation states were also studied. In 5N hydrochloric acid, the chemical yield was independent of the antimony oxidation state. For arsenic however, the yield of arsenic was 7 times greater for As(III) than for As(V). (auth)

7624 THE RAPID SEPARATION OF RARE EARTH MIXTURES BY THIN-LAYER CHROMATOGRAPHY. T. B. Pierce and R. F. Flint (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Anal. Chim. Acta, 31: 595-7(Dec. 1964).

Thin-layer chromatography was applied to the separation of rare earths using di(2-ethylhexyl) hydrogen phosphate (HDEHP) retained on a vinyl chloride-vinyl acetate copolymer, Cervic, as the stationary phase. A plot of the zone-migration parameter against the log of the acidity of the mobile phase was found to approach the expected value of −3. (M.C.G.)

7625 PURIFICATION PROCESSES FOR HIGH-PURITY MATERIALS. O. N. Carlson and D. T. Peterson (Ames Lab., Ames, Iowa). Electrochem. Technol., 2: 282-5(Sept.-Oct. 1964). (IS-852)

The basic elements of separation processes were formulated in a general unified pattern and are discussed in terms of the distribution of components between phases. The driving forces for these separations and methods of manipulating the conditions so as to achieve the most thorough separations are related to physical and chemical properties of the components. The special requirements of processes for high-purity materials are discussed, and examples of successful processes are cited to illustrate the general principles. (auth)

7626 PREPARATION OF CARRIER-FREE Y^{90} FROM Sr^{90} WITH ION EXCHANGE. Y. Suzuki (Tokyo Univ.). Intern. J. Appl. Radiation Isotopes, 15: 599-602(Oct. 1964).

The cation-exchange preparation of ^{90}Y from ^{90}Sr was carried out with 1% ammonium oxalate solution as the eluant. The elution required a smaller volume of eluant than did methods employing citrate, and no pH adjustment was necessary in preparation of the eluant. Ammonium oxalate eluant can also be employed for the separation of the rare earths from alkaline earths in fission products. (auth)

7627 ANION EXCHANGE CHROMATOGRAPHY OF TRANSITION METALS IN TARTRATE MEDIUM. Gerald P. Moore and Thomas R. Sweet (Ohio State Univ., Columbus). J. Chromatog., 16: 201-6(Oct. 1964).

The tartrate complexes of chromium, molybdenum, nickel, silver, cadmium, and mercury were studied by the batch equilibration method on Dowex 2X-8 anion exchange resin. From the distribution coefficients obtained for the above metals and for manganese, cobalt, zinc, and iron, several column separations were developed. Radioisotopes were used in the batch equilibration studies and in the chromatographic separations. (auth)

7628 STUDIES ON THE SYNTHETIC INORGANIC ION EXCHANGERS. I. SYNTHESIS OF STANNIC PHOSPHATE AND SOME OF ITS PROPERTIES. Yasushi Inoue (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem., 26: 2241-53(Dec. 1964).

For the purpose of developing ion exchangers expected to have radiation stability, synthetic inorganic ion exchangers were studied. First, stannic phosphate was prepared by various methods, and its properties, such as composition, exchange capacity, and chemical stability, were investigated in relation to the methods of synthesis. The content of phosphate increased with an increase of the mixing ratio of PO_4^{3-}/Sn^{4+} up to a value 2 and then became constant at the maximum phosphate to stannic ratio of ¼ of the stoichiometric value. Exchange capacity depended on the phosphate content of the exchanger, and it was assumed that fixed ion originates from the phosphate to stannic ratio, had maximum exchange capacity of 1.3 to 1.5 meq/g. This exchanger was unstable in concentrated hydrochloric acid and alkali even in dilute solution, but fairly stable in nitric acid as zirconium phosphate. Mutual separation of alkali metals was determined for the examination of the selectivity and availability for the column operation of the exchanger. By using various concentrations of ammonium chloride as an eluent, complete separation of sodium, potassium, and cesium from each other was achieved with relatively small column. (auth)

7629 SOME APPLICATIONS OF THE REGULAR SOLUTION THEORY TO SOLVENT EXTRACTION. I. DISTRIBUTION OF β-DIKETONES. T. Wakahayashi, S. Oki, T. Omori, and N. Suzuki (Tohoku Univ., Sandai). J. Inorg. Nucl. Chem., 26: 2255-64(Dec. 1964).

As an attempt to establish a theoretical treatment of solvent extraction, two fundamental equations, to represent the distribution equilibrium of certain species between two phases, were deduced by application of the regular solution theory. The validity of these equations was verified using β-diketone as an example. The distribution coefficients of acetylacetone, trifluoroacetylacetone, and thenoyltrifluoracetone between various organic solvents and an aqueous solution of the ionic strength of 0.10 with sodium perchlorate at 25°C were photometrically determined and the data tabulated. When an empirical value was employed as a solubility parameter of aqueous solution, these equations were confirmed to be distinctly valid. Using a distribution data of acetylacetone, the solubility parameter of aqueous solution was evaluated to be 16.35 and 17.55 by the two equations respectively. These values were also appropriate for the distribution of other β-diketones. The following values were obtained as solubility parameters from the two equations, respectively: 10.6 and 10.5 for acetylacetone, 9.6 and 9.4 for trifluoroacetylacetone, and 10.1 and 9.9 for thenoyltrifluoracetone. (auth)

7630 SOME APPLICATIONS OF THE REGULAR SOLUTION THEORY TO SOLVENT EXTRACTION. II. DISTRIBUTION OF SCANDIUM CHELATES. T. Omori, T. Wakahayashi, S. Oki, and N. Suzuki (Tohoku Univ., Sendai). J. Inorg. Nucl. Chem., 26: 2265-70(Dec. 1964).

The distribution of scandium chelates with β-diketones such as acetylacetone (AA), trifluoroacetylacetone (TFA), and thenoyltrifluoracetone (TTA) was investigated. It was found that there exists an evident correlation between the distribution coefficient of a scandium chelate for an organic solvent and that of the corresponding β-diketone. This correlation can be expressed as $\log D_M = n \log D_{\beta\text{-}0} + K$. This empirical relation was explained quantitatively by applying the regular solution theory. (auth)

7631 EXTRACTION OF METALLIC CATIONS BY MONO-ACIDIC ORTHOPHOSPHATE ESTERS IN A MONOMERIZING DILUENT. G. W. Mason, S. Lewey, and D. F. Peppard (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 26: 2271-84(Dec. 1964).

The extraction of M^{2+} (Ca and U(VI) as UO_2^{2+}), M^{3+} (Am(III), Eu(III), Er, Tm, Y, and Sc), and M^{4+} (Th) from an aqueous HCl phase into an extractant phase consisting of a monoacidic orthophosphate ester in n-decyl alcohol as diluent was studied. The extractants, di 2-ethylhexyl phosphoric acid, $(C_8H_{17}O)_2PO(OH)$, HDEHP, and di[p-(1,1,3,3-

tetramethylbutyl)phenyl] phosphoric acid, $[(C_8H_{17})C_6H_4O]_2$-PO(OH), HDOΦP, were monomeric in the alcohol diluent, forcing extraction by a monomeric mechanism in the low concentration range, so that the extractant dependency was the same as the charge of the cation under study. (In contrast, the extractant dependency in corresponding systems employing hydrocarbon diluent in which these extractants were dimeric were reported as 2.5 and 3.0 for Ca^{2+} and 3.0 for Th^{4+}, the former dependencies being greater and the latter dependency less than the charge on the ion.) A simultaneous extraction with an extractant dependency equal to twice the charge of the cation was operative for the M^{2+} and M^{3+} cations studied. For Th(IV), this extraction was sixth-power rather than eight-power extractant dependent. A study of the variation of log K with Z, including all lanthanides(III) except Gd, for which a suitable radiochemical tracer was not available, revelaed an odd-even effect. The plot of log K vs Z was best represented as separate odd-Z and even-Z curves for both HDEHP and HDOΦP. (auth)

7632 A SIMPLE METHOD FOR SEPARATING MACRO-QUANTITIES OF PROTACTINIUM AND NIOBIUM. D. Brown and P. J. Jones (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 26: 2296-7(Dec. 1964).

Methods for separating protactinium and niobium were studied. The most successful method involved the extraction of niobium from $HF-H_2SO_4$ mixtures by diisobutyl carbinol. (M.C.G.)

7633 SEPARATION OF AMERICIUM (CURIUM), BERKELIUM AND CALIFORNIUM BY EXTRACTION CHROMATOGRAPHY. J. Kooi, R. Boden, and J. Wijkstra (CEN-SCK, Mol, Belg.). J. Inorg. Nucl. Chem., 26: 2300-2(Dec. 1964).

An extraction chromatography procedure for the separation of americium, curium, berkelium, and californium is described. The elements are extracted from di-(2-ethylhexyl)orthophosphoric acid (HDEHP). The method avoids the use of oxidizing and/or reducing agents and requires only dilute HCl for elution. Columns with kieselguhr/HDEHP ratios of 8.5 gave sharper elution curves. (M.C.G.)

7634 SEPARATION OF ^{140}La FROM A $^{140}Ba-^{140}La$ MIXTURE BY COPRECIPITATION WITH FERRIC HYDROXIDE, USING ORGANIC BASES AS PRECIPITANTS. Y. Koda (Government Industrial Research Inst., Nagoya, Japan) and S. Takagi. J. Inorg. Nucl. Chem., 26: 2303-4 (Dec. 1964).

Experiments were carried out to separate pure ^{140}La from a $^{140}Ba-^{140}La$ mixture by coprecipitation with ferric hydroxide using aqueous ammonia and several organic bases as precipitants. The degree of contamination of ^{140}Ba in ^{140}La was determined by analysis of the β-decay curve of the precipitate. In general, the quantity of ^{140}Ba coprecipitating with ferric hydroxide decreased with the concentration of OH^- ion in solution. (M.C.G.)

7635 THE EXTRACTION OF NITRIC ACID BY TRI-n-OCTYL AMINE. J. M. P. J. Verstegen (Institutt for Atomenergi, Kjeller, Norway). J. Inorg. Nucl. Chem., 26: 2311(Dec. 1964).

The extraction of HNO_3 from aqueous phases by organic solutions of tri-n-octyl amine (TOA) was explained by Sato (J. Inorg. Nucl. Chem., 26: 1295(1964)) by the formation of a hydrogen bond between HNO_3 and TOA. It was concluded that the data suggest that the anionic part of $(TOAH)NO_3$ is a nitrate ion, perhaps slightly deformed by hydrogen bonding with the proton. The high heat of formation cannot be explained by hydrogen bonding. (M.C.G.)

7636 SURFACE DIFFUSION PHENOMENA IN GASEOUS DIFFUSION. II. SEPARATION OF BINARY GAS-MIXTURES. Kunio Higashi, Hiroo Ito, and Jun Oishi (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 1: 298-304 (Nov. 1964).

The degree of separation in gaseous diffusion accompanied by surface diffusion flow was calculated. The results were verified by experimental results on the separation of a mixture of butane and propane. Notably, the heavier component, butane, was enriched on the lower pressure side, contrary to the separation effect of Knudsen. It was also experimentally verified that Knudsen's law is perfectly applicable to the analysis of the separation on unadsorbable gas mixtures. (D.C.W.)

7637 EXTRACTION OF RADIORUTHENIUM BY NITROBENZENE SOLUTION OF POLYVINYL CHLORIDE. Yoshio Koda (Government Industrial Research Inst., Nagoya, Japan), Motoharu Tanaka, and Tsu-Chang Hung. Radioisotopes (Tokyo), 13: 450-4(Nov. 1964). (In Japanese)

The method is highly selective and allows the separation of radioruthenium from mixtures of fission products. When a large amount of sample water has to be treated as in the determination of radioruthenium in natural waters, ruthenium is preferably copreciated with hydrous ferric oxide prior to the final extraction step. The procedure is briefly given below: 5 mg of ferrous ion and 10 ml of 3% hydrogen peroxide solution are added to every 1 liter of sample water, and pH of the solution is adjusted to about 6 using bromocresol purple as an indicator. The resulted hydrous ferric oxide is filtered through a glass filter. The precipitate is then dissolved in hot 1 N sulfuric acid. The solution is cooled and about 0.4 g of argentic oxide is added. After 10 minutes' standing at room temperature, the oxidation of ruthenium to the octavalent state is quantitative. Ruthenium tetroxide thus formed is then extracted with 0.1% nitrobenzene solution of polyvinyl chloride. Radionuclides such as ^{36}Cl, ^{90}Sr, ^{90}Y, ^{99}Tc, and ^{74}As are not extracted, distribution of these nuclides in favor of organic phase being very low. The over-all recovery of ruthenium of more than 98% is attainable. Ruthenium separated from mixtures of fission products shows a γ-ray spectrum identical to that of pure $^{106}Ru-^{106}Rh$. Distribution ratio of ruthenium tetroxide between 1N sulfuric acid and the nitrobenzene solution of polyvinyl chloride is as high as 1,000. Distribution ratios of ruthenium tetroxide between 1N sulfuric acid and some other organic solvents are also given. (auth)

7638 REMOVAL OF ^{137}Cs ON A NIIGATA MONTMORILLONITE CLAY BY COLUMN TECHNIQUE. Masao Takizawa (Inst. of Physical and Chemical Research, [Japan]), Kugao Koda, Shigetane Uehara, and Akio Hirokawa. Radioisotopes (Tokyo), 13: 455-61(Nov. 1964). (In Japanese)

Natural clay in rod of 1 mm dia. × 2 – 5 mm was prepared from a predominately Ca saturated montmorillonite (100%), which is a commercial bleaching earth from Ōmi, Niigata prefecture, with polyvinyl acetate (10%) as a binder. Portions of the natural clay in rod were converted to Na- and H-forms by treating with 1N solutions of the corresponding chloride. Through a column (2 cm dia.) of 20 g of natural, H-, or Na-clay in rod, the test solutions containing ^{137}Cs 1.0×10^{-2} μc/ml were percolated at a flow rate of 10 ml/min at room temperatures. The cesium capacities of the three clay columns were measured by the effluent volume (ml/g of clay) at a specific activity ratio (C/C_0) of 0.05. Na-Clay column was incomparatively superior in cesium capacity to natural and H-clay columns, and the pH value of the feed most suitable for ^{137}Cs removal on Na-clay was a range of 6 to 9, as was also indicated for ^{90}Sr removal. Comparative effects of competing various cations on the cesium capacity of Na-clay column are in the order: $K^+ > Na^+ > Ba^{2+} (> Al^{3+}$ (pH 2.3)) $> Ca^{2+} > Sr^{2+}$ for neutral 1.0×10^{-1}N aqueous solutions of the corresponding chloride, because the effluent volume values at C/C_0 of 0.05 for the above systems in the presence of these cations were found to be 30, 170, 440, 770 (pH 2.2), 2,400 and 3,900 ml/g, respectively. Effects of increasing K, Na, and Ca concentrations on the cesium capacity of Na-clay column can be expressed as the linear relations between the effluent volume in ml/g at C/C_0 of 0.05, x, and log (the initial concentration of the corresponding chloride in N, y): $\log y = \log(1.07 \times 10^{-1}) - (2.58 \times 10^{-3})x$, for 0.01 – 0.1N KCl, neutral; $\log y = \log(1.06 \times 10^{-1})x$, for 0.05 – 0.1N NaCl, neutral; and $\log y = \log 1.32 - (4.66 \times 10^{-4})x$, for 0.1 – 0.5N $CaCl_2$, neutral. (auth)

7639 SEPARATION OF BISMUTH FROM LEAD, COPPER AND OTHER ELEMENTS BY MEANS OF ANION EXCHANGE. F. Feik and J. Korkisch (Universität, Vienna). Talanta, 11: 1585-9(Dec. 1964).

The anion-exchange behavior of bismuth and various other elements was investigated in media consisting of methyl glycol and nitric acid. Through determination of the distribution coefficients in such mixtures, a method for anion-exchange separation of bismuth from many metal ions was developed. A mixture of 90% methyl glycol and 10% 5M nitric acid was found to be a suitable medium for this separation on the strongly-basic anion exchanger Dowex 1, X8. Only bismuth, thorium, and lanthanum were strongly retained on the resin in these conditions. All other elements investigated, such as lead, copper, iron, etc., were either only weakly adsorbed or were not absorbed. By means of this ion-exchange procedure, a series of analyses of copper-base alloys for bismuth was carried out. The results showed that this method can be used successfully for the quantitative isolation of bismuth from such materials. The final determination of bismuth in the eluates was performed by complexometric titration. (auth)

7640 SEPARATION AND DETERMINATION OF TANTALUM AND NIOBIUM BY PRECIPITATION FROM HOMOGENEOUS SOLUTION. R. Dams and J. Hoste (Universiteit, Ghent). Talanta, 11: 1599-1604(Dec. 1964).

An attempt to separate niobium and tantalum by precipitation from homogeneous solution by thermal decomposition of their peroxy complexes, in the presence of tannin and oxalate, was only moderately successful. A more satisfactory separation of tantalum and niobium for ratios from 50:1 to 1:30 was obtained by extracting the bisulfate melt with ammonium oxalate before adding hydrogen peroxide, hydrochloric acid, and tannin. For a tantalum/niobium ratio of 1:1 the niobium coprecipitation was reduced to 5%. Furthermore, two alternative possibilities are presented: a quantitative recovery of a tantalum precipitate at small oxalate and high tannin concentration, leaving 90% of the tantalum-free niobium in solution, and an 85% recovery of niobium-free tantalum at high oxalate and small tannin concentration. A study of the coprecipitation process of niobium showed that the distribution coefficients follow a logarithmic pattern and that true homogeneous mixed crystals are formed. (auth)

7641 ANION-EXCHANGE SEPARATION OF BERYLLIUM, VANADIUM AND OTHER ELEMENTS FROM LARGE AMOUNTS OF URANIUM. J. Korkisch and S. S. Ahluwalia (Universität, Vienna). Talanta, 11: 1623-6(Dec. 1964).

A method is described for the anion-exchange separation of small quantities of beryllium, vanadium, magnesium, calcium, aluminum, gallium, and indium from gram amounts of uranium. For this purpose, a medium consisting of 95% methanol and 5% 5M nitric acid was passed through a resin bed of Dowex 1, X8. By subsequent washing of the resin with a methanol-nitric acid mixture of the same composition, these metal ions were preferentially eluted from the column, whereas uranium was still retained by the anion exchanger. In the eluates the elements were determined by means of spectrophotometric or titrimetric procedures. (auth)

7642 EXTRACTION OF SCANDIUM HYDROXYQUINOLINATE BY CHLOROFORM. I. P. Alimarin, V. M. Krasikova, and I. V. Puzdrenkova. Vestn. Mosk. Univ., Ser. II, No. 3, 50-3(May-June 1964). (In Russian)

Scandium as the hydroxyquinolinate was quantitatively extracted by chloroform at acidities from pH 5 to 1N NaOH. Ultraviolet and visible spectra data on the extract indicated that the extracted compound has the same composition in the organic phase for all conditions studied. (IIC-M,G.)

7643 THE USE OF ION-EXCHANGE CHROMATOGRAPHY FOR SEPARATING THORIUM FROM CERIUM. I. P. Alimarin, A. M. Medvedeva, and M. A. Burlova (Moscow Inst. of Fine Chemical Tech.). Zh. Analit. Khim., 19: 1332-5(1964). (In Russian)

The behavior of cerium on cation exchange resin in solutions of different acidity was studied. It was established that at HCl concentrations of more than 3.6N cerium is not sorbed on the cation exchange resin. The possibility of separating thorium from cerium by ion exchange chromatography was studied. It is shown that thorium is completely sorbed at HCl concentrations between 3.6 and 4.0N, whereas cerium passes almost completely into the filtrate. Thorium is extracted from the resin by ammonium oxalate due to the formation of a complex ion $[Th(C_2O_4)_3]^{2-}$. The suggested method was used for separating thorium in the analysis of monazite. (auth)

7644 EXTRACTION OF RARE EARTH NITRATES BY SATURATED ALCOHOLS. E. A. Belousov and S. D. Khakhaev (Inst. "Boris Kidrich," Belgrade). Zh. Neorgan. Khim., 9: 2659-63(Nov. 1964). (In Russian)

The distribution coefficients of Pr, Sm, Ho, and Yb nitrates, in extraction by n-butyl, n-hexyl, n-heptyl, n-nonyl, isobutyl, and isoamyl alcohols, increased as the HNO_3 concentration in the aqueous phase increased. With the higher alcohols (n-heptyl and n-nonyl) K_d was very small. The order of these alcohols, according to their ability to extract rare earth nitrates, is n-butyl, isobutyl > (n-amyl, isoamyl) > n-hexyl > n-heptyl > (n-octyl) > n-nonyl. Between n-butyl, isobutyl, isoamyl, and n-hexyl alcohols and 0.01N HNO_3, the distribution of Ce, Pr, Eu, and Y nitrates increased only very slightly if at all with increasing NH_4NO_3. At low acidities, n-butyl alcohol differed little from tributyl phosphate in extraction power for the rare earths. (tr-auth)

7645 EXTRACTION OF URANYL THENOYLTRIFLUOACETONATE. N. Milich, O. M. Petrukhin, and Yu. A. Zolotov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR and Inst. "Boris Kidrich," Belgrade). Zh. Neorgan. Khim., 9: 2664-7(Nov. 1964). (In Russian)

Studies were made on the extraction of U(VI) (2.5×10^{-4}M) from acetate-buffered solutions by 0.1M thenoyltrifluoroacetone in benzene, $CHCl_3$, CCl_4, amyl acetate, cyclohexanone, n-butyl alcohol, isoamyl alcohol, 0.036M tributyl phosphate-CCl_4 systems, and 2.7M acetone-CCl_4 systems. Extractions depended greatly on the nature of the organic phase. The distribution coefficients in the extractions by oxygen-containing solvents was 1 to 2 orders higher than by benzene and other non-oxygenated solvents. The addition of tributyl-phosphate, cyclohexanone, or acetone to CCl_4 increased the distribution coefficients. (tr-auth)

7646 DISTRIBUTION PAPER CHROMOTOGRAPHY OF RARE EARTH MIXTURE AND STRUCTURAL SALTING-OUT THEORY. G. M. Varshal and M. M. Senyavin (Inst. of Ore Deposit Geology, Petrography, Mineralogy, and Geochemistry, Academy of Sciences, USSR and Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 5: 681-90(Sept.-Oct. 1964). (In Russian)

The influence of cation salting-out on the extraction of complex rare earth nitrate-thiocyanate and nitrate-trichloroacetate ions from aqueous solutions and on the chromatographic separation of rare earth mixtures was investigated from the point of view of structural theory. Data on the distribution coefficient and magnitude R_f of various rare earths (Nd, Gd, Y, Er, and Lu) agree with a concept of hydration and dehydration of complex rare earth solvates and exhibit many regularities observed in previous studies on uranyl nitrates. (R.V.J.)

7647 CONTINUOUS ELECTROLYSIS AND SEPARATIONS IN FLOWING SOLUTIONS. John H. Strohl. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 78p.

A single stage apparatus, utilizing crushed graphite as the electrode material, was used for the continuous quantitative electrolysis of flowing solutions. This device was applied to the oxidation of Ce(III) to Ce(IV), the selective reduction of U(VI)–Fe(III) mixtures, the separation of mixtures of Cu, Pb, Cd, and Zn, and the continuous removal of Pb from a Pb–Cd mixture. Good selectivity was possible and the procedures were relatively rapid. Some mixtures of metals cannot be quantitatively separated with a single stage device. A study of a chromatographic process using a mercury film as stationary phase was done using an apparatus of rather low efficiency. The apparatus was simi-

lar to a chromatographic column in form and utilized a mercury-coated platinum packing. Pb and Tl showed the expected dependence of retention time on the potential applied to the packing and also showed definite migration along the packing. Sn and In showed much less ideal behavior. The study indicated that more efficient equipment would be necessary for quantitative separations. (Dissertation Abstr., 25: No. 2(Aug. 1964).)

7648 PROCESSING IMPURE URANIUM. Robert J. Teitel and Gilbert S. Layne (to Dow Chemical Co.). U. S. Patent 3,148,975. Sept. 15, 1964. Filed Dec. 11, 1961.

A method was developed for purifying impure uranium, which consists of heating the uranium with copper or a copper-magnesium alloy of at least 70% copper. This alloy is made molten and completely miscible with molten uranium. The melt is then heated with enough magnesium to cause precipitation of a uranium-containing solid. Radioactive contaminants removed from the treated uranium metal are recovered in a concentrated, readily disposable form by this method. (M.C.G.)

7649 PROCESSING IMPURE URANIUM. Robert J. Teitel (to Dow Chemical Co.). U. S. Patent 3,148,976. Sept. 15, 1964. Filed Dec. 11, 1961.

A method was developed for processing of impure uranium, which consists of heating the uranium metal with at least 4 parts of an Al-Cu alloy per part of uranium so that the metals become molten and are almost completely mutually miscible. The Al-Cu alloy consists of at least 55 wt % Al, at least 15 wt % copper, and no more than 5 wt % of other metals. This melt is heated with enough magnesium to cause precipitation of a uranium-containing solid. This method may be used for remotely controlled purification of uranium. (M.C.G.)

ENGINEERING

General

Refer also to abstract 8574.

7650 (CONF-641201-2) SHIPMENT OF A LARGE LIQUID SOURCE—A CASE HISTORY. F. A. Ernest and R. Maher (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Dec. 1964. Contract AT(07-2)-1. 13p. Dep.(mn); $1.00(cy); 1(mn) OTS.

From American Institute of Chemical Engineers Annual Meeting, Boston.

Equipment was designed for shipment of 150 gallons of nitric acid solution containing 26,000 curies of alpha activity from americium and curium isotopes and 200,000 curies of associated rare earth fission products. Some of the design features were (a) a pressure vessel, rated for 1200 psi at 560°F, placed within the cask to contain the product solution; (b) a catalytic recombiner in the pressure vessel to recombine radiolytically decomposed product solution; (c) aluminum honeycomb shock absorbers within the cask, surrounding the pressure vessel; (d) a specially modified existing 40-ton lead and steel cask; and (e) massive external crash and rollover shrouds on the depressed-center railroad car which carries the cask. The shipping equipment meets or exceeds requirements of proposed AEC regulations for shipping radioactive materials with respect to containment during normal shipping conditions and in event of an accident involving impact, puncture, loss of coolant, and fire. As an added precaution, because of the extreme hazard presented by loss of containment, a special couriered train was provided which was limited in speed to 30 mph and was scheduled to avoid oncoming traffic. In addition, a test shipment of water in the equipment was made over the same railroad route prior to the first actual shipment. The first of the two planned shipments of americium and curium isotopes to ORNL was completed in December 1963 without incident. (auth)

7651 (NAA-SR-Memo-10067) RESPONSE OF A TWO-DEGREE-OF-FREEDOM SYSTEM TO A GROUND APPLIED SHOCK. C. C. Rampton (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 10, 1964. Contract AT-11-1-GEN-8. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The mathematical expressions necessary to describe the response characteristics of a two-degree-of-freedom system under the action of a ground applied half sine wave acceleration are given. This "idealized" mathematical model will be used to describe the action of the S8DRM1 reflector system. It should be noted that the masses of the fixed reflector system and the drum system are nearly equal and are considered such. (auth)

7652 (NYO-2539-3) STRUCTURAL INTEGRITY OF SHIPPING CONTAINERS FOR RADIOACTIVE MATERIALS. PART IV. A DISCUSSION OF APPROACHES TO THE VEHICLE-COLLISION PROBLEM. K. D. Doshi (Franklin Inst. Labs. for Research and Development, Philadelphia). Dec. 1964. Contract AT(30-1)-2539. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The problem of determining the forces acting on containers during accidents of their highway carriers is considered. The problem is defined, and three different approaches to the problem are outlined: experimental, analytical, and analytical-experimental. The latter approach is probably the best one for planning a research program for studying the vehicle-collision problem. (D.L.C.)

7653 (RL-REA-1) INCREASING WATER FILTRATION AT HANFORD. R. W. Pitman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1964. Contract AT(45-1)-1350. 18p. Dep.; $1.00 (OTS).

Early water treatment experience and water quality analysis by turbidity measurements at Hanford are described. Mockup studies of innovations in water treatment are described; these innovations include the replacement of filter media, the elimination of coagulation aid, and the addition of filter conditioner. The operation of the Hanford plant at high filter rates and the conversion of municipal plants to the Hanford process are discussed. (D.L.C.)

7654 (UCRL-7445) MEASUREMENTS OF THERMALLY INDUCED STRESS WAVES IN A THIN ROD USING BIREFRINGENT COATINGS. A. L. Austin (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 7, 1964. Contract W-7405-eng-48. 43p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

When an elastic body is heated rapidly, significant inertial stresses are developed if the imposed heating rates cause a substantial temperature change in times which are short relative to the mechanical response time of the body. This work describes a method for inducing and measuring the thermally induced elastic stress waves in an unrestrained thin rod. Rapid heating was accomplished electrically by discharging a low-inductance capacitor bank (0.1 μH, 2800 J) through the rod. Utilizing the frozen-stress technique, an initial fringe pattern was introduced into thin strips of a birefringent material securely bonded to each side of the rod. The longitudinal strain oscillations were measured by direct observation of the movement of the fringe patterns with a high speed framing camera. Interpretation of these measurements required a dynamic calibration and application of a dynamic correction factor for the reinforcing effect of the coating. Oscillations with periods from 35 to 250 μsec and stress amplitudes up to 9000 psi were measured and compared with the uncoupled thermoelastic theory. Good agreement was obtained, and it was concluded that this technique is suitable for transient measurements in the presence of large magnetic fields which normally restrict the use of electronic methods. (auth)

7655 BENDING AND STRETCHING OF ELASTICALLY COUPLED CIRCULAR PLATES ON ELASTIC FOUNDATION. Zenons Zudans (Franklin Inst., Philadelphia). Nucl. Struct. Eng., 1: 21-46(Jan. 1965).

The general problem of the bending and stretching of two elastically coupled circular plates on elastic foundation subjected to axisymmetric thermal and static loadings is defined and solved. Coupling between in-plane and out-of-plane deformation is considered as well as the arbitrary location of the points of fixity of the coupling elements with respect to the plate middle surfaces. Stiffness matrices of the coupling and the foundation elements introduced in the definition of the strain energy allow any desired degree of sophistication when evaluating the compliance of these elements. The general decoupled solution, together with a number of special cases of practical importance, is also given. The equations for the computer programming of the general solution are included. The solution is well suited for the analysis of core support plates of nuclear reactor pressure vessels as well as to the closely spaced double tube sheet heat exchangers of nuclear submarines. (auth)

7656 OVERALL EFFICIENCY TRENDS IN A COAXIAL GUN PLASMA ENGINE SYSTEM. Bernard Gorowitz, Allen Ruess, J. Kenney, and P. Gloersen (General Electric Co., Philadelphia). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-706, 15p, $1.00. (CONF-640801-24)

From 4th Electric Propulsion Conference, Philadelphia.

The efficiency of conversion of capacitor-stored energy to exhaust stream energy of a repetitively pulsed two-stage coaxial plasma engine was determined calorimetrically for various capacitances, voltages, gas density profiles, and gun geometries. The observed efficiency trends led to empirically determined optimum gun lengths, electrode radius ratios, and energy storage voltages. (J.R.D.)

7657 CLASSICAL PHYSICS IN MODERN SPACE PROPULSION: HEAVY PARTICLE BEAM FORMATION BY ELECTRICAL SPRAYING OF LIQUIDS. Charles D. Hendricks (Univ. of Illinois, Urbana). 11p. (CONF-407-7)

From Electro Chemical Society, Toronto, May 1964.

A short introduction is given to some of the problems of electric propulsion in order to emphasize the classical aspects of this modern field of research and development. A discussion is presented of the application of electrical spraying of liquids to the problems of modern electric propulsion of space vehicles. Recent experimental and theoretical results are discussed, including high-speed photomicrography and mass spectrometry, and the advantages of heavy charged particle propulsion systems are pointed out. (auth)

7658 INDUCTIVE ENERGY COUPLING IN A PULSED, SHAPED FIELD PLASMA ACCELERATOR. R. L. Haslund (Boeing Co., Seattle). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-703, 11p, $1.00. (CONF-640801-30)

From 4th Electric Propulsion Conference, Philadelphia.

Experimental results on the plasma current formation phase that satisfies the requirements of a high-density plasma accelerator are presented. The results verified the induced plasma current behavior predicted by theoretical analysis. (J.R.D.)

Applications of Nuclear Explosions

7659 (SC-RR-64-1239) CRATERS FROM TWO CHARGES BURIED IN VERTICAL ARRAY. Luke J. Vortman (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract AT(29-1)-789. 132p. Dep.; $4.00(cy), 3(mn) OTS.

A series of experiments was performed to study the crater dimensions produced by two 64-pound HE charges fired in a vertical configuration at varying depths and with varying distances between the charges. Firings were made both simultaneously and with time delays. For simultaneous firings, the dimensions are usually between those of a single charge equivalent in weight to the two charges and those of a single charge equivalent in weight to one of the charges. For long-time-delay firings (5.5 seconds, with the top charge fired first), crater depths are greater than for a single charge equivalent in weight to the two charges for one spacing, while other dimensions fall in the range mentioned above. This increased depth is potentially the most valuable characteristic of the dual-charge technique. Short-time-delay firings (1 to 10 msec) produced depths about the same as and radii and volumes smaller than either simultaneous or long-delay shots. (auth)

7660 (UCRL-7608) A MINING EXPERIMENT IN GRANITE. Dave Rabb (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 2, 1963. Contract W-7405-eng-48. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An experiment using the Hardhat 5.4-kt event was conducted to determine whether the chimney of broken rock produced by a deeply buried nuclear explosive could be drawn by conventional techniques. The experiment took place on Feb. 15, 1962, in a granodiorite-quartz monzonite intrusive porphyry. Drilling operations, geologic studies, and radioactivity levels are described. It is concluded that nuclear explosives can be used to break large quantities of hard rock, and that the broken rock can be safely mined. (D.L.C.)

7661 (UCRL-12065) LABORATORY VERIFICATION OF PLOWSHARE EXPLOSION CALCULATIONS. PART I. J. R. Hearst and L. B. Geesaman (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 1, 1964. Contract W-7405-eng-48. 21p. Dep.; $1.00(OTS).

To test computer programs which calculate the effects of underground nuclear explosions for the Plowshare Program, experiments have been performed using high explosives in well-known media. The results of these experiments have been compared to one- and two-dimensional calculations. Comparison has been of pressure, cavity radius, and shock position vs time. Agreement is, in general, within 10%, showing that for the situations examined, the computer programs are reasonably correct. The media were a liquid (water) and an elastic-plastic solid (plexiglas). Pressure was measured with tourmaline, whose calibration is shown to 20 kbars. (auth)

Facilities and Equipment

Refer also to abstracts 8579, 8580, and 8582.

7662 (NAA-SR-Memo-10181) SNAP-10A PbSnTe T/E PUMP S/N-030 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 8, 1964. Contract AT(11-1)-Gen-8. 24p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe T/E Pump S/N-030 was Acceptance Tested in accordance with Test Specification NA0204-005, Revision "A", and data as obtained, is submitted with a short summary of the results. The maximum output obtained during the "Orbital Full Flow Test" was measured as 15.10 gpm of 1010°F NaK at a pressure of 1.062 psi. The maximum output obtained during the "Pre-Reactor Startup Test" was measured as 0.30 gpm of 90° NaK at a pressure of 0.0059 psi, with a startup current of 40 amperes d-c. Based on the results of the above tests, T/E Pump S/N-030 meets the requirements of the Test Specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup Test" requirements. (auth)

7663 (NAA-SR-Memo-10386) EFFECT OF MERCURY VAPOR ON THE OPERATION OF CARTRIDGE HEATERS IN VACUO. R. Blevitt and G. D. Reynolds (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 28, 1964. Contract AT-11-1-GEN-8. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The evaluation and testing of Mercury Rankine systems often requires the use of electrical resistance-type cartridge heaters to supply heat. Terminals of these heaters may be required at times to operate in a mercury vapor atmosphere varying from 5×10^{-3} to 760 torr at various states of superheat or saturation. Such conditions arise during startup and steady state operation of mercury systems which do not possess 100% hermeticity. The results of tests simulating startup and steady state modes of reactor simulator heaters showed that mercury vapor did not adversely affect heater operation. In the 5×10^{-3} torr pressure range, the vapor behaved much like air. At higher pressures ~700 torr at 72°F, under condensing conditions, some mercury deposited on the terminal seal and caused insulation resistance to drop; however, these films were evaporated easily by lowering the test system pressure and thereby restoring the insulation resistance. Thermodynamic evaluation of the reaction of hot mercury vapor with the heater insulation (Magnesia) indicates that the magnesia is inert to attack. (auth)

7664 (NAA-SR-Memo-10401) ACCEPTANCE TEST OF PSM-3 DC CONDUCTION NaK PUMP (MRP). W. H. Wickes (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 2, 1964. Contract AT-11-1-GEN-8. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The d-c conduction NaK pump was installed in a recirculating loop and operated at 75°F and 1000°F to determine compliance with design specification. Performance is mapped over the range of 0–20 gpm flow and 0.2 to 5.0 psi discharge pressure in accordance with Test Specification NA0204-010. At the design condition of 71 lb/min flow and 3 psi discharge pressure, power required was 885 amp. Magnetic flux in throat is 3800 Gauss. The pump met all design requirements and was delivered for assembly into the PSM-3 system. (auth)

7665 (ORNL-TM-1001) PRELIMINARY EXPERIMENTAL GAS-COOLED REACTOR SPENT FUEL SHIP-

PING CASK DESIGN. L. B. Shappert (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A preliminary design and appropriate design information were developed for an Experimental Gas-Cooled Reactor irradiated fuel shipping cask. Criteria examined included criticality, shielding, fission product heat dissipation, structural integrity and fire protection. A preliminary cask operating procedure was also developed. It was concluded that such a cask could be designed to conform with all the requirements of the proposed Code of Federal Regulations, Title 10, part 72, dated September 23, 1961. (auth)

7666 THE DESIGN OF A PROTECTIVE RADIUM AND RADIOISOTOPE LABORATORY. F. T. Farmer and J. W. Haggith (Royal Victoria Infirmary, Newcastle-upon-Tyne, Eng.). Brit. J. Radiol., 37: 938-43(Dec. 1964).

A dual purpose laboratory for handling radium containers on the one side and high activity isotopes on the other is described. Master-slave manipulators mounted on an overhead track with motor drive serve most of the radium bench. Sphere units are used only over the sink for washing. A Pantasafe is installed behind the protective wall, and storage drawers for made-up radium are built into the back of the bench. Sterilizing by autoclave is carried out before the radium leaves the bench. For this purpose the items are sealed into nylon bags which are finally transferred by a lifting device into a shielded trolley for carriage to the theatre. On the other side provision is made for dispensing of the commonly used isotopes, both sterile and nonsterile, with the minimum of exposure. Calibrations are made with an ionization chamber behind the protective wall, and solutions are ampouled or bottled and sterilized as required. (auth)

7667 ULTRACENTRIFUGES. Hans-Georg Elias (Eidgenossische Technische Hochschule, Zurich). Chem.-Ingr.-Tech., 36: 504-22(May 1964). (In German)

Recent developments in the design of analytical and preparative ultracentrifuges are described with special reference to commercially available equipment and to the requirements of the sedimentation theory. (auth)

7668 MEASUREMENT OF THE ION FLUX EMANATING FROM OXIDE COATED EMISSION FILAMENTS IN A SIEMENS ELECTRON MICROSCOPE. J. R. Parsons and L. M. Howe (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Sci. Instr., 41: 773-5(Dec. 1964).

A Faraday cage, inserted into a Siemens Elmiskop I and used in conjunction with in-microscope radiation damage experiments, is described. It is positioned and the microscope is operated so that it can discriminate and hence separately measure either the oxygen ion or the electron flux simultaneously emitted from oxide-coated filaments (auth)

7669 NUCLEAR AND STRUCTURAL ASPECTS OF THE NASA SPACE PROPULSION FACILITY. W. J. Dodson and E. F. Nielsen (Kaiser Engineers, Oakland, Calif.). Nucl. Struct. Eng., 1: 91-7(Jan. 1965).

The National Aeronautics and Space Administration's Space Propulsion Facility, recently designed by Kaiser Engineers and currently being constructed at NASA's Plum Brook Station, is a large multi-purpose complex which will be used for the evaluation and testing of nuclear-powered and other types of spacecraft under simulated outer-space environmental conditions. A description is given of the nuclear and structural aspects of the design of this unique facility. (auth)

7670 A GENERAL PURPOSE ALPHA-GAMMA HOT LABORATORY. H. M. Glen (Oak Ridge National Lab., Tenn.). Nucl. Struct. Eng., 1: 98-107(Jan. 1965). (ORNL-P-370)

The design for a general purpose hot-cell laboratory that embodies the maximum safety for operating personnel handling source material containing airborne alpha-gamma emitters is discussed. The layout of this alpha-gamma hot-cell complex is predicated on the assumption that the in-cell research, process, or experimentation is always performed remotely, that sufficient remote handling equipment is available at all times to clear the cells of gamma emitters, and that equipment setup and removal and maintenance are done by properly protected personnel. (auth)

7671 A GAM-NEU VIEWING WINDOW DESIGN. T. E. Northup (Oak Ridge National Lab., Tenn.). Nucl. Struct. Eng., 1: 108-17(Jan. 1965). (ORNL-P-188)

A discussion is presented on radiation sources, design criteria, neutron and gamma shielding equations, effective removal cross sections, window configuration, standard terminology, and the construction requirements for a single Gam-Neu window. A design approach for a Gam-Neu window is presented as a guide for the development of future shielded viewing window concepts. (auth)

7672 ION PROPULSION FOR SPACE FLIGHT. Ernst Stuhlinger. McGraw-Hill Series in Missile and Space Technology. New York, McGraw-Hill Book Co., 1964. 389p. $17.50.

The properties and capabilities of ion or electrostatic propulsion systems including their efficacy for various space missions are discussed. Basic theory, specific designs, and experimental results on ion motors are also described. Electrothermal, electrodynamic, and photon propulsion systems are considered, and the flight mechanics of electrically propelled spacecraft are treated. (C.E.S.)

7673 PRECURSOR AND OTHER EFFECTS IN THE ELECTRICALLY DRIVEN SHOCK TUBE. H. G. Ahlstrom, D. W. Mahaffey, L. Sanga, and R. I. Schoen (Boeing Scientific Research Labs., Seattle). 32p. (CONF-471-48)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

An examination of the nature, cause, and magnitude of precursor effects in 6-in. electromagnetically driven shock tubes is presented. The separation of the shock from the hot gas associated with the discharge is also discussed. The shock tube is of sufficient length to allow study of shock-wave propagation after the discharge is terminated and of sufficient diameter to minimize tube wall effects. It is concluded that the main precursor effect is caused by vacuum uv radiation. (J.R.D.)

Heat Transfer and Fluid Flow

7674 (AGN-8121) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, July 1–September 30, 1964. C. R. Fisher and P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1964. Contract AT(04-3)-368. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Preliminary results are presented of the boiling heat transfer studies. Critical heat flux data are given for Rb and Cs in linear and swirl flow and for K in swirl flow, and their correlation by the mist or fog flow model is discussed. Calculated pressure drops for boiling Rb in swirl flow are compared with experimental data. Progress is reported for the thermophysical property studies. (D.L.C.)

7675 (APED-4625) PHASE VELOCITIES IN BOILING FLOW SYSTEMS BY TOTAL ENERGY AND BY DIFFUSION. Edward E. Polomik (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Mar. 1, 1964. 41p.

A total energy balance is employed in a single component boiling flow system to obtain minimum limiting values of vapor volume content (maximum slip ratio) and show the effects of phase velocity distributions. The results are compared to the data compiled by various investigators in steam–water systems at pressures of 115 to 2000 psia. Equations are evaluated for relationship of steam fraction and voids at 614 psia. Use of the results as a basis for extension to more refined relationship is illustrated. A correlating function is derived from the generalized diffusion velocity for momentum. This function is used to obtain satisfactory correlations of Argonne's steam voids data in a boiling channel at 163 and 614 psia with velocities

in the range 1.83 to 5.94 ft/sec and steam qualities between 0.008 and 0.07. A simple semi-theoretical relationship between quality, vapor fraction, and energy addition/unit boiling volume is finally obtained which correlates all of the 163 psia data within about 5 percent. A limited amount of the data for 614 psia is correlated equally well. (auth)

7676 (BAW-1280-20) SODIUM-HEATED STEAM GENERATOR DEVELOPMENT. Progress Report, October 1964. (Babcock and Wilcox Co., Barberton, Ohio). Contract AT(11-1)-1280. 65p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The design criteria that are important in the design of steam generators are outlined. Design work on the full-size steam generator is complete. Progress on the prototype steam generator is reported; stress, performance, materials selection, and fabrication problems are discussed. The partial decarburization of Croloy 2¼ steel exposed to 980°F sodium and the precipitation of carbides in type 316 stainless steel exposed to 1100°F sodium in a test boiler are reported. The corrosion rate of Croloy 2¼ steel in Na–10% NaOH at 900°F was found to be ~3 times the rate for Na–5% NaOH at the same temperature. The engineering analysis of the sodium–water reaction in a boiler is considered briefly. (D.L.C.)

7677 (BAW-3238-5) NONUNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Quarterly Progress Report No. 5, July–September 1964. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3238. 37p. (EURAEC-1255). Dep.(mn); $2.00(cy), 1(mn) OTS.

Experimental and analytical investigations are being conducted to determine the effects of irregular heat flow through reactor channels on the operating conditions that cause burnout (departure from nucleate boiling). Tubular specimens having four axial power shapes and annular specimens having five power shapes will be used, and an effort to correlate the experimental data with empirical and analytical models will be made. Data were obtained from the test section having the chopped-cosine heat flux shape. Further progress was made in modifying the facility and the test section instrumentation to provide more information than was obtained from the uniformly heated test section. (auth)

7678 (EURAEC-1163) SEVEN-ROD BUNDLE NATURAL CIRCULATION STABILITY AND BURNOUT TESTS WITH WATER AT UP TO 30 ATMOSPHERES PRESSURE. Special Technical Report No. 15. R. W. Bowring (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt), and C. L. Spigt (Eindhoven, Netherlands. Technische Hogeschool). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Stability and burn-out natural circulation tests on an electrically heated 7-rod cluster were carried out to obtain data relevant to the Halden II reactor. The object of the tests was to measure the maximum channel powers obtainable without burn-out at pressures up to 28 atm and various inlet subcoolings. The test section heat flux was essentially uniform, but local heat flux peaks were introduced at hot patches to probe burn-out. It was found that at 28 atm and up to 6°C inlet subcooling, a channel power of nearly 600 kw could be reached without burn-out or instability; a further increase of the subcooling reduced the burn-out power. The instability channel power threshold was investigated and found to decrease with decreasing pressure. In addition, the natural circulation inlet velocity was measured at various constant pressures and values of inlet subcooler heat removal, as a function of channel power up to and in the hydraulic instability region. Periodic flow oscillations of period about 1 second were observed and recorded together with the burn-out detector signal at trip under these conditions. (auth)

7679 (EURAEC-1200) HEAT TRANSFER AND MIXING STUDIES IN A P.W.R.-REACTOR-LOOP. Second Quarterly Progress Report, April 1, 1964–July 1, 1964. (Eindhoven, Netherlands. Technische Hogeschool). Aug. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 11-63-9- TEEN. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A brief account is given of the improvements made in the instrumentation and installation for studying heat transfer and mixing in an electrically heated pressurized water loop. These improvements include void measurements, pressure gages, temperature measurements, burnout detection, and test sections. The planned research program is outlined. (D.L.C.)

7680 (GEAP-4733) A PROGRAM OF TWO-PHASE FLOW INVESTIGATION. Sixth Quarterly Report, July–September 1964. F. W. Staub and N. Zuber (General Electric Co., Schenectady, N. Y. and General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 14, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 60p. (EURAEC-1235). Dep.(mn); $2.00(cy), 2 (mn) OTS.

Experiments at constant heat input and reduced pressures below 0.25 were completed. The preparation of a topical report summarizing both our void information and that of other authors was begun. The analysis and correlation of the pressure drop and heat transfer coefficient information is being delayed until the complete work on the void fraction results is issued. The operation of the experimental equipment continues to be satisfactory during the constant heat input tests and during several preliminary oscillating heat input tests carried out with the old condenser previous to its removal in August. (auth)

7681 (KAPL-3070) HYDRODYNAMIC STABILITY OF A BOILING CHANNEL. PART 4. A. B. Jones (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 18, 1964. Contract W-31-109-eng-52. 50p. Dep.; $3.00 (OTS).

A number of additions and modifications were made to the basic STABLE-4 program. These permit greater program flexibility and utility and incorporate statistically determined correlations for the Bankoff parameter, K_2, which appears in the slip ratio model, and for two parameters which occur in the subcooled-boiling model. The basic mathematical model is otherwise essentially unchanged from that reported in KAPL-2290. (auth)

7682 (NAA-SR-Memo-9851) CYCLE OPTIMIZATION SYSTEM (CYCLOPS-1)—AN IBM 7094 PROGRAM FOR HEAT AND MASS BALANCE OF THERMODYNAMIC SYSTEMS. J. A. Hessler, L. R. Blue, and J. L. Grimaldi (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 15, 1964. Contract [AT (11-1)-Gen-8]. 110p. Dep.(mn); $4.00(cy), 3(mn) OTS.

The Cycle Optimization System-1 (CYCLOPS-1), is an IBM 7094 FORTRAN program for analysis of thermodynamic systems. It is a general purpose program that performs a heat and mass balance for thermodynamic systems composed of pumps, turbines, separators, heat exchangers, compressors, and flow throttling devices. These components may be connected in any desired fashion. The thermodynamic fluids that may be used in CYCLOPS-1 are water, air, nitrogen, and para-hydrogen. (auth)

7683 (NP-14544) DIRECT ENERGY CONVERSION SYSTEMS. SUPPLEMENT 1. HEAT AND MASS TRANSFER FROM THE SURFACE OF A CYLINDER WITH DISCONTINUOUS BOUNDARY CONDITIONS TO AN INCOMPRESSIBLE LAMINAR FLOW. Quarterly Technical Summary Report, June 1, 1964–August 31, 1964. Zeev Rotem and David M. Mason (Stanford Univ., Calif.). Sept. 30, 1964. Contract AF49(638)-1123). 71p.

Heat and mass transfer studies for flow over a cylinder having a longitudinal-strip source of heat or mass are presented. A theory for the two asymptotic cases of $Pr \to \infty$ and $Pr \to 0$ is developed, giving the temperature profile and the transfer rate for such a strip. The theory includes the effect of the conductivity of the heating strip material. It is shown that if the conductivity of the strip material is very high, then the transfer rate is a measure of local wall shear-stress provided the Prandtl number of the convecting fluid is high. Experimental studies described in-

clude electrochemical mass-transfer studies carried out on a rotating cylindrical electrode carrier, and heat transfer studies carried out in an oil tunnel. Fair correlation between theory and experiment was found. (auth)

7684 (NYO-3114-4) TWO-PHASE FLOW AND BOILING HEAT TRANSFER. Quarterly Progress Report, July-September 1964. G. B. Wallis, J. M. Turner, I. Bemberis, and D. Kaufman (Dartmouth Coll., Hanover, N. H. Thayer School of Engineering). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3114-1. 58p. (EUR-AEC-1247) Dep.(mn); $3.00(cy), 2(mn) OTS.

A much improved correlation of pressure drop and void fraction data for vertical annular two-phase flow has been achieved by allowing for liquid entrainment. Results for two tube diameters and two very different liquids are correlated satisfactorily. A program of work on pressure drop has been started to complement previous entrainment studies. A study of the stability of a horizontal liquid surface is being undertaken to investigate the mechanisms of wave formation and entrainment. (auth)

7685 (TID-21403) FLOW INSTABILITY AND CRITICAL HEAT FLUX IN HEATED PARALLEL CHANNELS. J. E. Casterline and Donald M. Lee (Columbia Univ., New York. Engineering Research Labs.). Oct. 27, 1964. Contract AT(30-3)-187. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Tests results are reported for flow instability and burnout experiments with a test section having three parallel 0.5-inch ID tubes, with 76-inch heated length. The tubes were heated electrically, and internally cooled by water flowing in forced convection vertically upward at outlet pressures of 500, 1000, and 1500 psia. The ranges of variables studied were: heat flux, 0.25 to 1×10^6 Btu/hr-ft^2; mass velocity, 0.75 to 2.5×10^6 lb/hr-ft^2; inlet subcooling, 15 to 195°F; and exit quality, 10 to 50 wt %. The effects of orificing in the exit piping on the coolant stability and critical heat flux limits were also investigated. It was observed experimentally that there were operating conditions that caused pronounced hydraulic interaction between the heated channels, while the flow to the assembly gave no indication of flow instability. In many of these cases, the flow disturbances were of such magnitude that the flow to the most affected channel dipped to zero at the minimum point of the oscillation. The tendency toward flow instability was greatest at low pressures, low mass velocities, and with flow restriction in the exit piping. (auth)

7686 (UCRL-7838) NUMERICAL METHODS FOR NONLINEAR RADIATION TRANSPORT CALCULATIONS. Philip M. Campbell and Robert G. Nelson (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 29, 1964. Contract W-7405-eng-48. 56p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

Several methods for numerical treatment of the nonlinear radiation transport problem are investigated, viz. equilibrium diffusion, nonequilibrium diffusion, a method based on the telegraph equation, and a Monte Carlo method. A simple radiative heating problem with constant absorption cross section is solved by each of the methods, and the solutions are compared. The Monte Carlo method is described in detail for a general, frequency-dependent calculation. The accuracy of the Monte Carlo method is investigated with respect to the following considerations: energy conservation; number of particles required; propagation of statistical error; truncation error; and convergence to a known solution. A series of radiative heating problems with simple frequency-dependent absorption cross sections are solved by the Monte Carlo method. Gray-body solutions using mean absorption coefficients are compared with the frequency-dependent solutions. (auth)

7687 (ORNL-tr-377) PRESSURE LOSS IN THE LAMINAR FLOW OF A FLUID THROUGH A POROUS BED. G. Manzoni, L. Matteuzzi, and G. C. Pinchera. Translated for Oak Ridge National Lab., Tenn., from Ingegnere (Milan), [38]: No. 8, 1964. 20p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The RAPTUS concept is a fast reactor using a slurry of UO_2 in sodium. In order to study the circulation of sodium in the slurry, studies were made of the pressure loss in fluid flow through a porous bed under conditions simulating these in the RAPTUS core. The correlations were tested by an experiment in which lead shot in a hydrogenated terphenyl mixture were used at Reynolds numbers of 0.04 to 1.3. (D.L.C.)

7688 IMPORTANCE OF NUCLEATION ACTIVATION AND NONSTATIONARY HEAT TRANSFER FOR THE HEAT TRANSFER IN NUCLEATE BOILING AND DROPWISE CONDENSATION. W. Kast (Forschungs-Gesellschaft Verfahrens-Technik e.V., Aachen). Chem.-Ingr.-Tech., 36: 933-40(Sept. 1964). (In German)

Nucleate boiling and dropwise condensation show similarity in dependence of heat transfer coefficients of temperature-difference, suggesting similar physical processes. Using the necessary work for nucleation activation, the probability of nucleation activation and its dependence on temperature-difference, nucleus radius, and edge angle is given. Heat transfer coefficients are obtained under following model assumptions: in nucleate boiling, the nonstationary heat flow from the superheated boundary layer to the growing bubble has the dominating effect; in dropwise condensation, a condensate layer is built up which is then transported to the drops formed around a nucleus, thus leaving the cooling plate between the drops without heat transfer resistance to the condensation heat flow. For nucleate boiling, mean, local, and time-dependent heat transfer coefficients and the growth of bubbles and maximum bubble radii are given. A function for the dimensionless heat transfer coefficient as product of two dimensionless groups of parameters is suggested. A plot of this function for various media (water, alcohol, sulfur dioxide, and others) shows a scatter of data by 40%. (18 references.) (D.E.B.)

7689 THE MEASUREMENT OF MASS FLOW AND LINEAR VELOCITY OF A GAS BY CONTINUOUS IONIZATION. C. G. Clayton and J. W. Webb (Wantage Research Lab., Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 15: 603-10(Oct. 1964).

A theoretical and experimental investigation was carried out to evaluate the characteristics of the continuous ionization method of gas-flow measurement when the radioisotope source is mounted upstream of the detector. The advantage of this system is that it can be used to measure mass flow. A formula was derived, which gives the collector current in terms of the ion density at the source position, ion transit distance, ion recombination coefficient, the pressure drop in the test section, and the gas velocity. This formula, which was confirmed experimentally over a particular flow range, can be used for design studies. It is also shown how the range of linear velocity but not of mass flow, can be extended by increasing the pipe diameter. (auth)

Materials Testing

7690 (HW-83608) PROGRESS IN NONDESTRUCTIVE TESTING. A SUMMARY OF HANFORD ACHIEVEMENTS IN THESE PROGRAMS UNDER GENERAL ELECTRIC 1952–1964. D. C. Worlton (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 1964. Contract AT(45-1)-1350. 40p. Dep.; $2.00(OTS).

Hanford's nondestructive testing programs from 1952 to 1964 are reviewed. Following the chronological development of these programs, a summary is presented of the fuel testing effort under which three separate, fully automatic inspection stations were developed and applied to the AlSi fuel processes to ensure core, cladding, and closure integrity of each fuel element. Following beneficial use of these test systems, similar inspection equipment was developed and successfully applied to the N-Reactor fuel process; results of this program are also summarized. Long range research and development programs oriented toward

the development of advanced ultrasonic, eddy current, thermal, and nuclear particle counting techniques were established as an outgrowth of the fuels effort, and progress under these programs is reviewed. Existing plant-wide problems guided the direction of the long range research and development activities, and provided incentive for immediate application of new test developments. Results contributed significantly to major plant programs; these are pointed out with a few illustrative examples. (auth)

Vacuum Engineering

7691 (UCRL-Trans-1166(L)) PRODUCTION OF ULTRAHIGH VACUUM BY MEANS OF A HEATED HYDROGEN CONDENSATION PUMP. E. S. Borovik, G. T. Nikolaev, and B. A. Sharevskii (Akademiia Nauk Ukr. S.S.R. Fiziko-Tekhnicheskii Institut, Karkov). Translated by Sergey Shewchuck (Univ. of California, Livermore), from a report of the Fiziko-Tekhnicheskii Institut, Akademii Nauk Ukranian SSR, Kharkov, 1963. 15p. Dep. (mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

A heated hydrogen condensation pump is described, with whose help there was obtained a pressure of $\sim 10^{-10}$ mmHg in a chamber of 60 liters volume. The dependence of the pressure in the chamber on time was studied for different regimes of "training" (conditioning) of the device, and it was shown that the pump appreciably cuts down the time required for obtaining a pressure of $\sim 10^{-10}$ mmHg, as compared with other types of heated arrangements with diffusion pumps. The speed or rate of outpumping was measured for the pressure interval 10^{-9} to 10^{-7} mmHg, and was equal to 600 l/sec. (auth)

GEOLOGY AND MINERALOGY

General

7692 (DASA-1357(App.G)(Vol.IV)) FAILURE OF CAVITIES IN HOMOGENEOUS ROCK UNDER DYNAMIC LOADING FROM NUCLEAR EXPLOSION. George B. Clark and Rodney D. Caudle (Missouri. Univ., Rolla. School of Mines and Metallurgy). Sept. 30, 1962. For Plesset (E. H.) Associates, Inc., Los Angeles. Contract DA-49-146-XZ-073. 73p. (AD-421616). $7.60(OTS).

Stress concentration about an underground opening and strength of rock, per se, do not constitute adequate criteria to define failure of openings in homogeneous rocks. The Griffith theory of failure and its application to the failure of materials in tension and shear are reviewed. There appear to be analogous criteria for crack propagation and failure for materials in compressive uniaxial, biaxial and triaxial stress fields, although no investigations are reported in this area. Existing rock strength data for uniaxial fields, unconfined, may be utilized to determine the conditions for initiation of cracks at the periphery of an opening. Crack propagation phenomena then become the determining factors, in combination with stress field parameters, in limiting the extent or degree of failure. Such parameters include crack velocity, confinement effects, energy flow, duration and magnitude of stress field and rock properties themselves. (auth)

7693 (IFA-MR-23) ABOUT THE MEASUREMENTS OF THE FLOWING PARAMETERS OF UNDERGROUND WATERS. E. Gaspar and M. Oncescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). 1964. 13p. Dep.(mn).

The use of radioactive tracers to determine the flow parameters of underground waters is considered in some detail. Some experiments carried out on the Black Sea coast (Năvodari) and on the Danubian plain (Ogrezeni and Ciorogîrla) are described. The determination of sensitivity and precision is discussed, and errors of the above experiments are given. Reduction of the errors by various means is considered briefly. (D.L.C.)

7694 (UCRL-Trans-1158(L)) SCALE FACTOR AND THE EFFECT OF STRENGTH IN DIRECTED EXPLOSIONS. V. M. Kuznetsov and E. N. Sher. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore), from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 3, 84-90(1963). 17p. Dep.(mn); $1.00(cy), 1(mn)OTS; $1.60 (fs), $0.80(mf) JCL.

Studies are reported on the detonation of high explosives on the surface of the ground mass for excavation. The scaling effect and the effect of the strength properties of the medium are studied. The use of delayed blasting for directed throw-out is considered. (D.L.C.)

7695 SEDIMENT RESEARCH IN AUSTRALIA. B. L. Campbell (Australia Atomic Energy Commission, Lucas Heights, New South Wales). At. Energy Australia, 7: No. 4, 13-17(Oct. 1964).

Use of radioactive tracers to observe the movement of solids and other sediment in Australian harbors and waterways is described. Discussions are included concerning tracer techniques and experiments in Hunter River and Botany Bay. (J.R.D.)

Natural Radioactivity and Fallout

7696 (AERE-R-4687) RADIOACTIVE FALLOUT IN AIR AND RAIN: RESULTS TO THE MIDDLE OF 1964. R. S. Cambray, E. M. R. Fisher, G. S. Spicer, C. G. Wallace, and T. J. Webber (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England and United Kingdom Atomic Energy Authority. Research Group. Chemistry Div., Woolwich Outstation, England). Nov. 1964. 41p. Dep.; $1.20(BIS), 6s.(HMSO).

Samples of atmospheric dust and rainwater have been collected from the United Kingdom and overseas. Results are presented of the analyses of these samples for various fission products and for the activation product ^{54}Mn. The concentrations of the long-lived fission products ^{137}Cs and ^{90}Sr in air and rain over the United Kingdom are, in 1964, about 75% of those in 1963. The deposition of ^{137}Cs and ^{90}Sr at Milford Haven for the first six months of 1964 is in smaller proportion, compared with 1963, due to differences in the seasonal incidence of rainfall. It is argued that the long-lived fallout debris in 1964 originated from a source in the upper atmosphere and that the tropospheric concentrations in future years may approximate to the 1964 level with but a small (~10%) annual diminution. Integration over the world of the deposition of ^{90}Sr in rain provides an estimate of the total global deposition to the end of 1963. The ratio of ^{137}Cs to ^{90}Sr in rain over the United Kingdom decreased from a mean value of 1.69 for the two years 1960/61 to 1.57 for the period 1962/63 possibly due to fractionation effects. (auth)

7697 (CEA-R-2434) LE RADON ET SES DERIVES A VIE COURTE DANS LA BASSE ATMOSPHERE. (Radon and Its Short-Lived Daughter Products in the Lower Atmosphere). Jean Servant (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 80p. Dep.(mn).

Thesis submitted to Université, Paris.

The variations of vertical and temporal distributions of natural radioactivity with geographical location in the lower atmospheric layers are shown. The content of radon and its short-lived daughter products are measured. Radon content is measured continually with a new apparatus, the sensibility of which is 0.2×10^{-11} Ci m^{-3} i.e., a fiftieth of the mean concentration near the soil. This apparatus allowed one to show that radioactive equilibrium between radon and its daughter products is realized when the atmosphere is stable. Air observations between 0 and 100 meters above the ground show that radon and its decay products are valuable tracers to mark the stability of the atmosphere. Under very stable nighttime conditions the radon accumulates in the former 30 meters of the air layer, at sunrise it ascends and at 9 o'clock attains 100 meters high. The removal rate of the air in the lower atmosphere is computed from the movement of this radon mass; it is equal to 90 per cent for a summer day. It is shown that this radon comes from the soil in which it diffuses by Brownian motion the intensity of which varies with the water content of the soil; its value for June 1958 is 6×10^{-17} Ci cm^{-2} sec^{-1}, and for January 1959 0.2×10^{-17} Ci cm^{-2} sec^{-1}. During the year 1958–1959 general mean of flux for the sedimentary soil studied is equal to $3.8 \pm 1.3 \times 10^{-17}$ Ci cm^{-2} sec^{-1}; it is identical to the world wide mean computed by H. Israel. (auth)

7698 (INS-R-32) TRITIUM IN SOUTHERN HEMISPHERE PRECIPITATION, 1953-1964. C. B. Taylor (New Zealand. Inst. of Nuclear Sciences, Lower Hutt). Aug. 1964. 70p. Dep.(mn).

All tritium measurements which were reported for Southern Hemisphere precipitation are presented together with unpublished results for New Zealand. The latitude variation of the fallout and the meterological and hydrological implications are discussed. (D.L.C.)

7699 (NP-14559) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 2, Number 5. (Canada. Dept. of National Health and Welfare. Radiation Protection Div., Ottawa). May 1964. 46p. Dep.(mn).

Data are presented on radioactivity due to fallout in samples of air, precipitation, and milk collected at various locations throughout Canada during April, 1964. Data are included on the content of ^{131}I, ^{137}Cs, ^{89}Sr, and ^{90}Sr in

samples of whole milk collected during 1963. Data are also included from programs on reactor environment monitoring, isotope safety assessments, field investigations of radiation safety, and personnel film dosimeter monitoring programs. (C.H.)

7700 (NVO-162-17) PROJECT ROLLER COASTER QUARTERLY RESURVEY, JUNE 1964. M. A. Glora and B. L. Brown (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). Aug. 1964. Contract AT(29-2)-162. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A resurvey of the Project Roller Coaster sites was conducted to determine current radiological contamination conditions and to repair exclusion fences, barricades, and radiation warning signs at appropriate locations. In all populated areas, water and swipe samples were collected for laboratory analysis. Assay of these samples revealed negative results. In addition, various work sites, equipment, and vehicles were surveyed with portable radiation instruments. The results of this survey were also negative. (N.W.R.)

7701 (NYO-2415-12) STUDIES OF NUCLEAR DEBRIS IN PRECIPITATION. James P. Friend (Isotopes, Inc., Westwood, N. J.). Nov. 30, 1964. Contract AT(30-1)-2415. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The data on the deposition of fallout in precipitation at Westwood, New Jersey, from January 1963 to the summer of 1964 are presented and discussed with reference to fresh debris, strontium-90 deposition and concentrations, and the presence of the tracer nuclides manganese-54 and iron-55. A climatological analysis of the relationships between strontium-90 deposition and rainfall amounts is presented, and the applicability of such an approach to models for world-wide strontium-90 deposition is discussed. (auth)

7702 (NYO-8925) DATING OF MARINE SEDIMENTS BY IONIUM AND PROTACTINIUM METHODS (thesis). Tadepalli P. Sarma (Carnegie Inst. of Tech., Pittsburgh). June 1, 1964. Contract AT(30-1)-844. 117p. Dep.(mn); $4.00(cy), 2(mn) OTS.

It is the object of this investigation to find reliable methods for dating marine sediments based on non-equilibrium secondary natural radioactivity, and to apply these dating methods to determine the times at which geologically significant events in the past have taken place. Radiochemical procedures are developed to isolate thorium, protactinium, and uranium from sedimentary materials following complete decomposition of the samples with HF plus H_2SO_4. ^{232}U, ^{229}Th, and ^{233}Pa are used as tracers for the chemical yields of uranium, thorium, and protactinium, respectively. The thorium and uranium samples were counted by surface-barrier solid-state alpha detectors. The ^{231}Pa activities were measured in a Frisch-grid ionization chamber. Multichannel pulse analyzer is used with both detectors. The absolute specific activities of ^{238}U, ^{234}U, ^{232}Th, ^{230}Th, and ^{231}Pa were determined in various sections of four different cores from the Pacific, Atlantic, and Indian Oceans. The ^{238}U and ^{234}U specific activities observed ranged from 0.6 to 2.3 dpm g^{-1}, whereas the ^{232}Th specific activities showed greater variations, of the order of 0.08 to 4 dpm g^{-1}. The $^{234}U/^{238}U$ activity ratios are close to unity within the experimental uncertainty of about 5–10 per cent. The variations in the ^{230}Th specific activities are considerable and they fluctuate between 0.6 and 55 dpm g^{-1}, depending on the location of the core and the depth at which the sample is taken. The ^{231}Pa specific activities are lower than those of ^{230}Th by a factor of about 10 in the top layers of the sediments, and by a factor of about 20 in the deep sections of the core. The excess ^{230}Th specific activities are calculated by subtracting the ^{234}U specific activities from the total ^{230}Th specific activities in the same sections of the cores. Similarly, the excess ^{231}Pa specific activities are obtained by subtracting the ^{235}U specific activities (0.046 times the ^{238}U specific activities) from the ^{231}Pa specific activities. In three of the cores analyzed, the excess ^{230}Th and ^{231}Pa specific activities decreased fairly steadily and nearly exponentially, especially below about 20 to 30 cm. From the slope of the semi-log plot of specific activity vs depth, the mean sedimentation rate at each location was calculated. In the Pacific core (Scripps MSN-2G), an average sedimentation rate of 0.86×10^{-4} cm yr^{-1} was obtained, whereas in the Indian Ocean core (Göteborg SDSE-137) the value of 3.3×10^{-4} cm yr^{-1} was obtained. In the Mid-Atlantic core (Lamont V16-21), the average rate was about 3.7×10^{-4} cm yr^{-1} which is unexpectedly small for an Atlantic core. In the North Atlantic core (Lamont A179-15), a deficiency of ^{230}Th relative to ^{234}U is present in some sections of the column. A geochemical model is constructed to calculate the ^{230}Th and ^{231}Pa specific activities in freshly deposited sediments, and thereby ascertain under what circumstances one can expect excesses and deficiencies of ^{230}Th with respect to ^{234}U and of ^{231}Pa with respect to ^{235}U. The ^{230}Th and ^{231}Pa deficiencies can be explained by high sedimentation rates of biogenic calcite, exceeding about 8×10^{-3} cm yr^{-1}. Because of the complications due to several components always present in sediments, it is evident that complete dissolution rather than partial leaching is necessary to obtain meaningful specific activities of the various radionuclides. Theoretical calculations were made to account for the diffusion-like mixing by subsurface organisms, underwater currents, or both. The effect of this pseudo-diffusion on the depth distribution has been calculated for ^{14}C, ^{231}Pa, and ^{230}Th activities, and for the $^{231}Pa/^{230}Th$ ratio. Of the four indices which might be used for dating sediments, (1) excess ^{230}Th specific activity, (2) ^{232}Th-normalized excess ^{230}Th activity, (3) excess ^{231}Pa specific activity, (4) excess ^{231}Pa/excess ^{230}Th activity ratio, the first seems to be of greatest utility for determining ages and sedimentation rates. The second quantity fluctuates as a result of rather large ^{232}Th variations. The last two indices are less precise and their applicability is limited to about 200,000 yr; besides, they are more affected by pseudo-diffusion. ^{14}C is affected even more by pseudodiffusion, leading to erroneously high previous estimates of sedimentation rates. For reliable ^{14}C dating, one must determine the activity of many points and also correct for pseudodiffusion. The ^{230}Th measurements are good for this. The ^{231}Pa excess and $^{231}Pa/^{230}Th$ ratio can also help to indicate the conditions of deposition. The core V16-21 is one of eight cores in which the Pliocene-Pleistocene boundary is believed to be present, according to Ericson, Ewing, and Wollin (1963). The boundary is at a depth of close to 165 cm in this locality. According to the ionium measurements made on this core, the apparent age of the boundary is close to $(503 \pm 20) \times 10^3$ yr. A more probable age, $(525 \pm 20) \times 10^3$ yr, results from making a correction for assumed and indicated mixing in the top layers. The ages of the uppermost sections of the core V16-21 calculated from the decay of excess ^{231}Pa and the excess ^{231}Pa/excess ^{230}Th ratio are in good agreement with the excess ^{230}Th ages. The dating of the Ericson-Ewing-Wollin boundary is the first time a geologically significant event has been dated by the ^{230}Th dating method, although it cannot be considered definitely established on the basis of this single core that this event is actually the beginning of the Pleistocene epoch. 500,000 yr is about the practical dating limit of the ^{230}Th method for such sediments, but in favorable cases (such as deep Pacific cores), this might be extended to 600,000 or 700,000 yr. For longer times a method based on the growth of the spontaneous fission product ^{129}I might be useful. (auth)

7703 (TID-21350) TRITIUM CONCENTRATIONS IN NATURAL WATER SOURCES IN THE EASTERN MEDITERRANEAN AREA. Final Contract Report, June 15, 1958–June 14, 1962. J. R. Gat and A. Nir (Weizmann Inst. of Science, Rehovoth, Israel). Nov. 1964. Contract AT-(30-1)-2166. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A description is given of the operation of a routine tritium laboratory in the Mediterranean area, based on the electrolytic enrichment and gas counting system. Improvements in instrumentation and procedures are discussed. Sample contamination and alternative assay methods are also discussed. (D.L.C.)

7704 INVESTIGATIONS OF THE AIR AND WATER ACTIVITY IN ATLANTIC OCEAN, BLACK AND CASPIAN SEAS. N. N. Alfimov, N. I. Matuzov, and P. N. Yagovoi. At. Energ. (USSR), 17: 309-10(Oct. 1964). (In Russian)

From June to October, 1959, studies were carried out of the specific activity of air and water samples taken in the Atlantic Ocean at various latitudes—from 60 to 0° north latitude. Sea water samples were taken from the ocean surface; the salt concentration was determined, the samples evaporated, and the β activity of the dry residue measured. The density of radioactive fallout in the air was determined simultaneously by the sedimentation method. The results are compared with those of previous measurements. The specific activities of dry residues of samples of sea water from littoral regions of the Black and Caspian Seas were determined by the same methods from July to August, 1959, and the Student-Fisher coefficient was derived. (M.J.T.)

7705 ON THE NEUTRON BACKGROUND AT THE EARTH'S SURFACE. G. V. Gorshkov, V. A. Zyabkin, and O. S. Tsvetkov. At. Energ. (USSR), 17: 492-6(Dec. 1964). (In Russian)

Slow neutron fluxes were measured over soil and water surfaces. The flux over soil proved to be 3.1 times that over water. Possible causes of the difference are discussed. Calculations were made of thermal fluxes on the surface of materials in which fast neutrons are produced by cosmic rays. It was concluded that the difference between slow neutron fluxes over water and soil is caused by cosmic-ray production of neutrons in the earth's crust. (tr-auth)

7706 ABOUT THE DISCUSSION ON THE DATA OF THE "LONG LIVING TOTAL BETA ACTIVITY" OF THE AIR. G. Keck (Tierarztliche Hochschule, Vienna). Atompraxis, 10: 489-91(Nov. 1964). (In German)

As shown by special analysis of data obtained since September 1961 on daily collected dust samples, the radioactive aerosols due to nuclear weapon tests showed an increasing trend. The normal daily data on total beta activity showed a maximum in January 1962. Fallout from different test series is considered. (auth)

7707 THE TRANSITION OF STRONTIUM-90 AND CESIUM-137 CONCENTRATIONS IN MILK. I. NOVEMBER 1961 TO OCTOBER 1962. H. Danbara, T. Mitsuhashi, S. Miyamoto, and H. Nozaki. Chikusan Shikensho Kenkyu Hokoku, No. 2, 19-27(1963).

^{90}Sr, ^{89}Sr, and ^{137}Cs contents of milk produced in 4 to 6 areas of Japan were measured from November 1961 to October 1962. The ^{90}Sr content was about 20 pC/g in November and December 1961, decreased to low levels between February and May 1962, and increased to a maximum of 40 pC/g Ca in September and October 1962. ^{137}Cs levels followed a similar pattern; concentrations greater than 100 pC/kg were obtained in December 1961. ^{90}Sr: ^{137}Cs and ^{89}Sr: ^{90}Sr ratios were also calculated. (Public Health Eng. Abstr., 44: No. 10, Oct. 1964)

7708 PRELIMINARY TESTS ON THE RADIOACTIVITY OF STRONTIUM-90 OF SEVERAL VEGETABLES TAKEN FROM THE GARDEN FRUIT MARKET OF BOLOGNA. M. Zanetti and F. Cutrufelli (Università, Bologna). Igiene Sanita Pubblica (Rome), 17: 1-11(Nov.-Dec. 1961). (In Italian)

Studies on the radioactivity of vegetables purchased at the most important produce center of the community, a source particularly suited to a continuous sampling service of this type, are reported in preliminary form. The vegetables chosen are generally eaten raw and thus the mineral content is not diminished by water in cooking. Those examined were carrots, radishes, lettuce, and fennels, all purchased from March 20 to April 5, 1961. A detailed account of the technique of chemical extraction, radiation dose measurement methods, and the electronics systems used is given. The ^{90}Sr radioactivity concentrations found were as follows: carrots, 26.02 pC/kg of fresh weight; radishes, 31.40 pC/kg; lettuce, 25.50 pC/kg; fennels, 12.07 pC/kg (these last were purchased in Tarquinia). These results, though providing humans far below the usual permissible limits, must be taken with reservation, since the effects of ionizing radiation, including chronic internal radiation, have not yet been determined. (BBB)

7709 VARIATION IN THE RATIO OF STRONTIUM-89 TO STRONTIUM-90 IN PRECIPITATION SAMPLES WITH SAMPLING HEIGHT. A. Aarkrog (Danish Atomic Energy Commission, Research Establishment, Riso). Nature, 204: 771(Nov. 21, 1964).

An analysis of the $^{89}Sr/^{90}Sr$ ratio at various heights during the period October 1961 to September 1963 is presented. Results showed that the $^{89}Sr/^{90}Sr$ ratios in the relatively dry months were significantly higher in the upper precipitation collectors than in the lower. In the explanation of this occurrence it is assumed that the dry deposit, which yields the higher concentrations in the upper precipitation collectors, is of greater particle size than the deposit from rain. Larger and heavier particles are deposited more readily than fine particles and consist of younger fission products (greater $^{89}Sr/^{90}Sr$ ratio) than the fine ones. (J.R.D.)

7710 STUDIES ON THE REMOVAL OF RADIOACTIVE STRONTIUM IN MILK BY CALCIUM-SUBSTITUTED ION-EXCHANGE RESIN, CHEMICAL CHANGES OF TREATED MILK, AND ITS RECOVERY. Yoichiro Omomo, Kiyoko Akamine, and Tomikichi Tsugo (Tokyo Univ.). Nippon Nogei Kagaku Kaishi, 38: 186-91(1964). (In Japanese)

Whole and fat-free milks were subjected to ion-exchange techniques designed to remove ^{89}Sr added as the chloride. Dowex 50W X4, Dowex 50W X12, and Amberlite IR-120 were used as strong cation exchangers, and Amberlite IRC-50 was used as a weak anion exchanger. The Ca substitution of Sr in milk was provided for by pretreating the resins with 2N and $CaCl_2$ solution. The milk/resin (M/R) ratio of Sr at various contact times and the resultant property changes in milk were studied. It was found that Dowex 50W X12 (20 to 50 mesh) was superior in performance to the other resins, but the differences among them were small. The Sr removal rate (%) was directly proportional to the contact time, but no difference was noted with flow speed of milk between 3 and 60 ml per min (by the column method). The most practical M/R ratio was found to be 10 to 20 (parts of milk per part of resin), and the greater this ratio the lower the removal rate. If the pH value of milk was at 5.3 to 5.4 before processing, this increased the removal rate. Various changes in the properties of milk were noted after treatment with resin for removal of Sr, but it was possible to restore the properties of milk to the original state by removing the increased Ca with a K-cycled resin. These Sr–Ca–K resin exchange processes in successive stages made it possible to remove more than 80% of ^{89}Sr and 65% of ^{134}Cs from the milk. (BBB)

7711 DETERMINATION OF ARTIFICIAL RADIOACTIVITY FROM FALLOUT IN MILK. M. Zanetti and F. Cutrufelli (Università, Bologna). Nuovi Ann. Ig. Microbiol., 14: 270-3(July-Aug. 1963). (In Italian)

This report represents a continuation of a previous work done in 1961 to determine the radioactive contamination in milk due to fallout nuclides. In this second survey the samples were taken from mountains and plain region in the Bologna district as well as in the city during 1962. According to expectations, the radioactivity in milk had increased since 1961 because of the renewal of nuclear weapon tests in the atmosphere; the increase was especially marked in regard to ^{90}Sr. The average levels for milk in Bologna were: Ca 1.18 g/l, $^{90}Sr-^{90}Y$ 13.79 pC/l, and ^{137}Cs 74.9 pC/l. It is pointed out that ^{137}Cs was not present in any of the samples taken before October 1962. Of particular interest is the fact that the maximum values for ^{90}Sr (52.4 pC/l) and ^{137}Cs (151.0 pC/l) were found in the samples taken in mountainous areas, demonstrating that the amount of radioactivity may vary widely according to topographical and geographical factors. A table is provided showing ^{90}Sr and ^{137}Cs concentrations of milk taken on 14 dates in 1962 in the city of Bologna and in 8 rural districts. The mean values for ^{90}Sr in Bologna (13.79 pC/l) and neighboring mountainous regions (37.5) were slightly higher than corresponding values for the same period in the United States (12.31, 31.7 pC). The year average values were 6.3 pC/l in Bologna and 5.5 in the U. S. (BBB)

7712 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT]. VOLUME V, NUMBER 10. (Public Health Service, Washington, D. C.). Oct. 1964. 63p. $0.50(GPO).

Separate abstracts were written for four sections of the report; for separate abstracts see 19: 7713, 7714, 7753, and 7754. (C.H.)

7713 FISSION PRODUCT GAMMA ACTIVITY IN SURFACE AIR—80TH MERIDIAN AND U. S. LOCATIONS, MAY 1964. William R. Collins, Jr. (Health and Safety Lab., AEC). Radiol. Health Data, 5: No. 10, 469-70 (Oct. 1964).

Fourteen air sampling stations near the 80th meridian (west) from Thule, Greenland, to Punta Arenas, Chile, make up the HASL 80th meridian network. Data are presented on the fission product γ activity in samples of surface air collected along this network during May 1964. (C.H.)

7714 STRONTIUM-90 IN HUMAN VERTEBRAE, 1962–1963. Joseph Rivera (Health and Safety Lab., AEC). Radiol. Health Data, 5: No. 10, 511-13(Oct. 1964).

Samples of human vertebrae from accident victims residing in New York City, Chicago, and San Francisco prior to 1963 were analyzed for ^{90}Sr content. The ^{90}Sr content in bone specimens was proportional to dietary $^{90}Sr/Ca$ ratios estimated from diet studies in the three cities. (C.H.)

Techniques and Equipment

7715 (AECL-2005) SURVEY OF HYDROLOGICAL APPLICATIONS OF TRACERS IN CANADA. C. A. Mawson (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). [1964]. 14p. Dep.; $0.50(AECL).

The use of tracers to study the movement of ground and surface waters on a small scale is discussed. Sampling methods and results are described. The use of dye and tritium is also considered. (D.L.C.)

7716 (AFCRL-62-878) DETECTION OF DISTANT EXPLOSIONS BY SEISMIC MEASUREMENTS IN DEEP BOREHOLES. Final Report. (Jersey Production Research Co., Tulsa, Okla.). July 31, 1962. Contract AF-19(604)-8346. 88p. (VESIAC-3547-VU)

Simultaneous measurements of seismic signals in adjacent cased and open boreholes are compared. In general, the same earth noise is recorded in both holes, and the response to a high amplitude unidirectional signal is the same in both holes. The conclusion is that the casing in a borehole has no detectable effect upon a seismic signal if the casing is cemented to the borehole wall and wall-coupled geophones are used. Design and performance features of a moving coil geophone for borehole use are described. The natural frequency is 1.2 cps and the sensitivity is 50 volts per centimeter per second. Including the amplifier, the line output sensitivity is 17,000 volts per centimeter per second. The input noise level of the amplifier is about 0.2 microvolt, which corresponds to ground motion of about 10^{-8} centimeters at 1.0 cps. A ball-drop method of geophone calibration is described. The improvement of signal-to-noise ratio with depth for the first "P" arrival was determined for the Prater No. 1 well in southwest Oklahoma. During pre-dawn periods when the local noise was at a minimum, a two-times improvement in signal-to-noise ratio was obtained between depths of 1,500 and 4,500 feet. Below 4,500 feet the improvement in signal-to-noise ratio was less, and no improvement was noted at 10,000 feet. A greater improvement was obtained during daylight hours, but it was a variable quantity dependent upon the level of the local noise. The experimental attenuation of noise with depth in the 0.5- to 6.0-cps frequency range did not agree with the theoretical attenuation computed for the first mode of Rayleigh waves. The apparent reason is that in a layered system the surface waves are propagated in more than one mode. At the higher frequencies, the higher modes are most important, and a complicated distribution of noise with depth should be expected dependent upon the layering. (auth)

7717 (NVO-977-2) SEISMIC PROFILING OF THE SOUTHEAST FLANK OF THE TATUM SALT DOME. Final Report, December 1962. V. R. McLamore and C. B. Forbes (United ElectroDynamics, Inc., Pasadena, Calif. and United Geophysical Corp., Pasadena, Calif.). Project DRAGON. Contract AT(29-2)-977. 51p. Dep.(mn); $3.00 (cy), 1(mn) OTS.

A seismic refraction survey was conducted to delineate the size and shape at depth of the salt dome. The survey revealed a high-speed refraction horizon at depths between 900 and 1750 ft along the line of profile. The apparent position of the salt face from the aplanatic curves was in error. (D.L.C.)

7718 (VUF-1013) ANALYSIS OF SHOAL DATA ON GROUND MOTION AND CONTAINMENT SAFETY PROGRAM. Final Report. (Beers (Roland F.), Inc., Alexandria, Va.). Sept. 21, 1964. Project SHOAL. 117p. (NVO-1163-30). Dep.; $4.00(OTS).

Predictions and evaluations of ground motion and containment were made for the 12.5-kt Shoal event. A comprehensive ground motion instrumentation program was designed. This program included four linear instrument arrays radiating northeast, northwest, southeast, and southwest with a total of 21 stations. Eight additional stations were emplaced at points of interest. Of the 29 stations, 21 were on hardrock and eight were on alluvium. Analysis of the seismic records included corrections for instrument response and derivation of non-recorded motions by differentiation or integration. It was determined that peak motions on alluvium were greater than on hardrock by a factor of 2.1 for acceleration, 3.7 for displacement, and 3.4 for velocity. The rates of attenuation indicated that peak motions on alluvium were not due to surface waves. The prediction equations for acceleration and displacement were found to represent reasonable upper limits of motion. The objective of the containment evaluation was to assure that appropriate measures had been taken to preclude unacceptable venting of radioactive isotopes to the atmosphere. Consideration was given to possible venting both at the time of the explosion and later when the cavity collapsed and a chimney formed. The adequacy of stemming of all man-made openings as well as the effect of geologic hazards such as faults or fissures were evaluated in the containment analysis. The possibility of a secondary explosion due to water entering the cavity was also examined. It was concluded that Shoal would be contained to the same degree as Hardhat and that the stemming plan was adequate. The prediction of containment was substantiated by the test results. Limited post-shot exploration allows the following comparisons: cavity radius—24.7 meters predicted, 25.6 ± 0.6 meters observed; chimney height—110 meters predicted, 108 meters observed; depth of spalling—122 meters predicted, 120+ meters indicated; radius of spalling—<914 meters predicted, 794 meters observed. (auth)

7719 RADIOCARBON DATES OF ARCHAEOLOGICAL SAMPLES. D. P. Agrawal, S. Kusumgar, and R. P. Sarna (Tata Inst. of Fundamental Research, Bombay). Current Sci. (India), 33: 402(Jan. 1964).

The acetylene synthesis method was used for the measurement of radiocarbon activity of samples. The radiocarbon dates were calculated on the basis of a 95% net activity of the oxalic acid standard, as the age-corrected value for pre-1900 wood. Two dates are given for each sample tested. The first date is based on the value of 5568 ± 30 yr for the half life of radiocarbon; the second date, given within parenthesis, is calculated on the basis of a recently measured half life value, 5730 ± 40 yr. All dates given are in years B.P.; for converting them to A.D./B.C., 1950 A.D. should be used as the reference year. All samples were given an initial treatment before processing through various chemical steps for the synthesis of acetylene from the sample carbon in order to remove extraneous intrusions. The samples were carefully inspected and

cleaned of foreign objects such as mud grains and rootlets. The samples were then treated with dilute HCl and subsequently boiled in a dilute NaOH solution to get rid of any humic acid present. NaOH pretreatment was avoided when the sample was too soft and expected to disintegrate. The sites from where the samples derived, their composition, and dates are as follows: Adichanallur, Madras, India (wood) 775 (795); Alamgirpur, U.P., India (bone) 1060 (1090); Hastinapur, U.P., India (charcoal) 1940 (2000); Kausambi, U.P., India (charcoal) 1655 (1705); Kudan, Nepal (charred wood) 935 (965); Mohanur, Madras, India (bone) 330 (340); Mohenjodaro, West Pakistan (charred grain) 3600 (3705); Nagarjunakonda, Andhra Pradesh, India (human bone) 1495 (1535); Rajar Dhibi, West Bengal, India (charcoal) 1230 (1260). For samples deriving from Nagarjunakonda, Adichanallur, Mohanur, and Alamgirpur all the ^{14}C dates are in complete disagreement with the archeological estimates. (BBB)

7720 NEUTRON METHOD FOR MEASUREMENT OF MOISTURE CONTENT OF SOILS. FUTURE PROSPECTS. V. A. Emel'yanov, L. N. Beskin, and V. I. Isipov. Pochvovedenie, No. 7, 109-15(1963). (In Russian)

The method is based on the slowing down of fast neutrons by hydrogen, the degree if deceleration being proportional to the amount of water present. The effects of other factors and of detectors and types of probes used are discussed. (IIC-M.G.)

7721 RADIOCARBON AND SOIL EVIDENCE OF FORMER FOREST IN THE SOUTHERN CANADIAN TUNDRA. Reid A. Bryson, William N. Irving, and James A. Larsen (Univ. of Wisconsin, Madison). Science, 147: 47-8(Jan. 1, 1965).

Radiocarbon dating of charcoal on podzols along a transect reaching 280 kilometers north of the present tree line from Ennadai Lake indicates that former forests were burnt about 3500 years ago and again about 900 years ago. These forests probably were associated with periods of relatively mild climate. (auth)

7722 FORMATION HYDROGEN CONTENT LOGGING WITH FAST NEUTRON AND SCINTILLATION DETECTOR. Hugh E. Hall, Jr. (to Texaco Inc.). U. S. Patent 3,149,230. Sept. 15,1964. Filed June 11, 1959.

Apparatus was developed for conducting a radioactivity well log of the formations traversed by a bore hole through the earth. An elongated instrument adapted to be passed through a bore hole was prepared, which consists of a source of fast neutrons for irradiating the formations and a detector for fast neutrons resulting from irradiation of the adjacent earth formation. The distance between the source and detector is such that the fast neutron flux reaching the detector as a result of the source is least affected by the position of the instrument in the bore hole. The neutron measurement provides an inverse indication of the hydrogen content of the formation. (M.C.G.)

Thorium and Uranium Minerals

7723 DEPTH OF SOURCE OF LEAD. Akimasa Masuda (Tokyo Univ.). Nature, 204: 567-9(Nov. 7, 1964).

The liquid fraction value, which indicates the quantitative fraction that a liquid at a certain stage of solidification occupies relative to the amount of initial liquid (unity), was evaluated for the source materials of leads. These values were reduced to the dimension of depth within the earth. The abundance relationship among U, Th, and ^{204}Pb estimated from the isotopic composition of lead of ores is shown. Results suggested that the most frequent seats of original sources from which lead in ores was derived are at about 150 km, with a range from 75 to 400 km. (M.C.G.)

7724 MEASUREMENT OF THE URANIUM AND THORIUM CONTENT OF ROCKS, USING AN E.M.I. 9530B, 5 INCH PHOTOMULTIPLIER TUBE. F. N. Byrne (Trinity Coll., Dublin). Sci. Proc. Roy. Dublin Soc., Ser. A, 1: 343-64(1963).

A method for the measurement of the uranium and thorium contents of some natural materials is described. The alpha emission from the surface of a powdered specimen was found using a photomultiplier tube and zinc sulfide scintillator, then the thorium content was measured by detecting the 2.62-Mev gamma from ^{208}Tl using a sodium iodide crystal and a photomultiplier tube. The thorium and uranium contents of some igneous rocks and also of some manganese nodules and other deep-sea deposits were found. A constant ratio between the thorium and uranium contents of the igneous rocks examined was not observed. The uranium and thorium contents of a natural material can be found by measuring the alpha emission from the surface of a powdered specimen, and the ^{208}Tl gamma emission from a bulk specimen. The gamma measurement gives the thorium content directly and enables calculation of uranium content from the alpha measurement. For the alpha counter a silver-activated zinc sulfide scintillator was used with a photomultiplier and for the gamma counter a large sodium iodide crystal coupled to a similar photomultiplier was used. (auth)

HEALTH AND SAFETY

Refer also to abstracts 7246, 7650, 7779, and 8644.

7725 (DPSPU-64-30-1) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, July–December 1963. (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Feb. 1964. Contract [AT(07-2)-1]. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

This report, for the period July 1 through December 31, 1963, presents the results of the environmental monitoring program for the atmosphere, for vegetation and food, and for water. In no case does the monitoring program reveal concentration of radionuclides in excess of 4.6% of the Maximum Permissible Concentrations. (auth)

7726 (EUR-1639.f) CERTAINES QUESTIONS D'ASSURANCE PORTANT SUR LE TRANSPORT PAR MER DE COMBUSTIBLES NUCLÉAIRES IRRADIÉS ET NON IRRADIÉS. (Report on Insurance Problems Relating to the Transport of Irradiated and Non-Irradiated Nuclear Fuels by Sea). (Langeveldt De Vos/De Waal & Zoon, Amsterdam). 1964. 102p. Dep.(mn).

A discussion is presented of the insurance of risks involved in the carriage by sea of both non-irradiated and irradiated nuclear fuels, the accent being on the latter, which give rise to the bulk of the safety problems. The enquiry covers, on the one hand, the situation in the Euratom Member States and on the other hand the situation in the United Kingdom and the United States. Although the liability of the shipper or the consignee is the focal problem, space is also devoted to damage to, or loss of, the carrying vessel and its non-radioactive cargo. A survey is given of the various forms of coverage offered by the leading insurance markets. Treatment of the various problems is based on current law, the Paris Convention of 29 July 1960 and the Supplementary Convention signed in Brussels on 31 January 1963. From the survey it is seen that the transfer of the liability to the operator is only being applied gradually in the marine transport sector. The carrier will therefore continue to demand from the consigning operator an absolute guarantee and also insurance up to as high an amount as possible. A passage is given over to the discussion of the advantages from an actuarial standpoint of carriage by chartered vessel or by a vessel owned by the operator, which offers the possibility of batching several consignments. Although in such cases supplementary insurance will be necessary, considerable savings will be made in transport third-party liability insurance. These economies will result mainly from the fact that only one collective insurance will need to be taken out for all the batched consignments. The aggregate capacity for the world's insurance markets is estimated roughly at more than 35,000,000 EMA u.a. (auth)

7727 (LADC-6030) HEALTH PHYSICS PLANNING FOR A HIGH-PRESSURE TRITIUM GAS EXPERIMENT AT A UNIVERSITY. Morris J. Engelke (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

This paper is concerned with the problems encountered in the use of a multicurie high pressure tritium gas target at a large university. The necessary administrative arrangements, state licensing, transportation, and health physics problems are discussed. (auth)

7728 (NVO-162-15) THE NEVADA TEST SITE ENVIRONMENTAL-SURVEILLANCE PROGRAM. M. A. Glora and B. L. Brown (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). July 1964. Contract AT (29-2)-162. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A comprehensive program of analysis and documentation of the radiological environment at the Nevada Test Site enables the casual exposure of personnel to radiation to be kept to a minimum, and provides a continuing radiological history of the NTS environs. From these data, the AEC-NVOO manager can estimate future land use and facility requirements, and evaluate proposed test requirements by all users. The data accumulated are valuable for relating radiation from tests to off-site-contamination conditions, and will become even more valuable as an industry-wide frame of reference for future installations and nuclear activities at other locations. Sampling and analytical methods used are described and data treatment methods are discussed. (C.H.)

7729 (ORNL-3691) NUCLEAR SAFETY PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1964. (Oak Ridge National Lab., Tenn.). Nov. 1964. Contract W-7405-eng-26. 123p. Dep.; $4.00(cy), 3(mn) OTS.

Progress is reported in sections on release and transport of UO_2 fission products in the Confinement Mockup Facility, release of fission products on in-pile melting of reactor fuels, behavior of fission products released during in-pile destruction of reactor fuels, characterization and control of accident-released fission products, nuclear safety pilot plant, reactivity effects of fuel displacements in plate-type reactors, and radiochemical plant safety studies. Separate abstracts were prepared for each section. (J.R.D.)

For abstracts of individual sections see: 7730, 7731, 7732, 8602, 8620, 8621, and 8622.

7730 (ORNL-3691(p.46-74)) CHARACTERIZATION AND CONTROL OF ACCIDENT-RELEASED FISSION PRODUCTS. (Oak Ridge National Lab., Tenn.).

Diffusion tubes were used to study the distribution of I_2 in aged aerosols, in conjunction with modified May packs which consisted of an absolute filter, Cu- or Ag-plated Cu screens, charcoal-impregnated filter paper, and a series of small charcoal beds. The unfiltered aerosol in the containment tank, produced by melting 7000 Mwd/ton irradiated UO_2, contained I_2 which was 70% molecular and 25% associated with particles in the 20- to 30-Å size range. The remaining 5% was distributed among larger particles and a charcoal-penetrating form presumed to be an organic I. Filtration of the aerosol by an absolute filter removed most of the particles larger than 50Å, while passage through Cu screens removed molecular I_2 and some that was associated with particles; of the remainder, that attached to particles in the 20- to 30-Å range and the penetrating form were the principal airborne I species. The latter form accounted for only about 0.3% of the total I inventory. Separate filter packs and diffusion tubes were used to determine the I_2 distribution in the aged aerosol from the confinement tank in the absence of heated fuel at three stages in the I tracer experiment: during depressurization, during Ar sweep, and during air sweep. An effort was made to determine, by the liquid contactor or scrubber method, the distribution of forms of radioiodine remaining airborne after several hours in the Confinement Mockup Facility. The purpose of the test was to supplement information being obtained from the May pack filter-absorbers and from data on deposition in diffusion tubes. Results indicate that this system must be thoroughly tested in order to give distribution data which can be interpreted unequivocally and that inclusion in the system of a filter having a known efficiency for very small I_2-bearing particles will aid interpretation of the data. The efficiency of May packs as I_2 samplers was investigated in two experiments by use of composite diffusion tubes connected to each section of the May pack. In the first experiment relatively dry filtered air was employed with I_2 which was 99.7% elemental and 0.3% I compounds. As indicated by the diffusion tubes, the behavior of the volatile I_2 in the May pack, in one test with fairly dry air, was observed to be generally consistent with the designed function of the May pack components. On the other hand, about 1% of the elemental I_2 was apparently not retained by the Cu gauze; if this is a usual oc-

currence, May pack measurements would incorrectly label part of the elemental I_2 as nonelemental. Mislabeling to this extent could be of considerable significance in connection with the design of high-efficiency I_2 removal systems. An experiment was performed to investigate certain anomalies which have been observed in the use of composite diffusion tubes. Six diffusion tubes having various arrangements of wall material were supplied with air bearing I_2 generated by the dichromate method. One of the diffusion tubes was heated to 100°C. The observations are tentatively interpreted to show the presence of at least two distinct iodine species other than I_2; one of the species seems to be relatively unstable. The deposition rate on rubber tubes does not appear to be primarily dependent upon diffusion, but is probably influenced by the dissociation of an I compound to yield HI or I_2. I_2 carried by particulates is not observed in the aerosol produced by the dichromate method. A heated diffusion tube yields an altered but interpretable distribution, and the usefulness of this arrangement for characterizing radioiodine in a moist atmosphere will be investigated further. Experiments continue to show that moisture interferes with the adsorption of volatile I_2 compounds at the charcoal surface but does not have as strong an interfering effect on the sorption of elemental I_2 vapor. Experiments were performed in an attempt to identify the volatile I_2 compound by making use of its solubility (partition) behavior in two different solvents, such as methyl iodide and water. Results indicate that the mixture containing volatile I compounds includes either methyl iodide or an I compound of similar solubility. The method for in-place testing of I_2 adsorbers on the Savannah was developed further by application to the 9000-cfm building ventilation system of the ORR. I_2 vapor labeled with ^{131}I is released into the ventilation duct and is measured before and after the I_2 adsorber. Satisfactory efficiencies were observed. Plans are being considered to establish a routine in-place testing procedure. Experiments showed that while activated charcoal is highly efficient for removal of volatile I_2 compounds from dry air at room temperature, its efficiency drops off sharply with increasing humidity; it is also a function of the nature of the I compounds present. The removal efficiency of the charcoal was shown to increase when the temperature of the adsorber was increased to about 100°C. It was also shown that coconut charcoal is the most effective of the three types of charcoal studied for the removal of the volatile (penetrating) I_2 fraction. Elemental I_2 was removed from air by charcoal with high efficiency for all conditions tested. Fibrous filters are being employed for the characterization of radioactive aerosols. By this method the distribution of radioactive particles in a series of uniform fiber filters is interpreted in terms of three main filtration mechanisms—diffusion, interception, and inertial impaction. Several experiments were performed to compare filters of 72 and 94% porosity. Streams of air, flowing at linear velocities from 0.4 to 88 fpm and carrying particles labeled with ^{65}Zn, which ranged in diameter from 20 to 300 Å, were passed through successive layers of identical filters. The filtration curves obtained were resolved into three straight lines indicating three different particle-size groups. The results also showed that decreasing the porosity reduced the amount of penetration. Decreasing the porosity seems to improve filter efficiency, particularly at intermediate flow rates (40 fpm), less so at lower (10 fpm) and higher (80 fpm) velocities, and negligibly at very low flow rates (2.5 fpm). (auth)

7731 (ORNL-3691(p.77-85)) NUCLEAR SAFETY PILOT PLANT. C. J. Barton, L. F. Franzen, P. P. Holz, L. F. Parsly, and T. H. Row (Oak Ridge National Lab., Tenn.).

Construction of the Nuclear Safety Pilot Plant (NSPP) was completed, and two experimental runs in which unirradiated UO_2 was melted were carried out during the report period. A number of plasma torch runs were made in connection with development of plasma flame melting of ceramic fuel elements under some of the operating conditions proposed for the NSPP. Three new sampling devices have been added: May-pack sampler for taking time-dependent aerosol samples and differentiating the chemical form of the I in these, a device for investigating how the diffusion behavior of the aerosol is changed by removal of some of its components by elements of the May pack, and a device for collecting time-dependent fallout samples. Technical revision of the Reactor Containment Handbook is now completed, and the Handbook is being indexed and edited for preliminary release. (auth)

7732 (ORNL-3691(p.101-3)) RADIOCHEMICAL-PLANT SAFETY STUDIES. C. E. Guthrie and H. W. Godbee (Oak Ridge National Lab., Tenn.).

The hazards associated with a large radiochemical plant were evaluated in a published report. One of the critical assumptions in this report was the characterization of aerosols formed by fires and explosions. Since little experimental work has been done in this area, an experimental program involving the combustion of organic solvents has been initiated. (auth)

7733 (ORNL-3697) HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1964. (Oak Ridge National Lab., Tenn.). Oct. 1964. Contract W-7405-eng-26. 266p. Dep.; $6.00(cy), 5(mn) OTS.

Progress in health physics is reported under 27 topics. Separate abstracts were prepared for 25 topics. Education, training, consultation, and cooperative projects are also discussed. (N.W.R.)

For abstracts of individual sections see: 6930, 6931, 6932, 6933, 6934, 6948, 6949, 7204, 7205, 7206, 7207, 7208, 7209, 7210, 7538, 7539, 7540, 7617, 7734, 7735, 8666, 8673, 8674, 8675, and 8676.

7734 (ORNL-3697(p.32-42)) CLINCH RIVER STUDY. F. L. Parker, K. E. Cowser, W. P. Bonner, P. H. Carrigan, Jr., R. J. Pickering, and B. J. Frederick (Oak Ridge National Lab., Tenn.).

Analyses of stable chemical constituents in discharge-weighted water samples from the Clinch and Tennessee Rivers show that variations in constituent concentrations are not great; bicarbonate is the predominant anion and calcium the predominant cation. Seasonal variations in concentration of several of the constituents were detected. Calculation of correlation coefficients for constituent pairs indicated that turbidity, apparent color, centrifuged color, suspended solids, iron, and manganese concentrations varied in a similar manner. Measurement of gross gamma radioactivity in 146 cores of Clinch River bottom sediment has shown that radioactive sediment up to 8.7 ft thick is present in the river. Tracer studies were conducted to study the effect of releases from Melton Hill Reservoir on dispersion of radioactive releases from White Oak Dam. Analyses of fish taken from the Clinch River show that about 2.5% of the maximum permissible intake (MPI) would be received from eating 37 lb of fish per year. Radiation levels near filter beds in water plants upstream and downstream from White Oak Creek are at background. Bottom sediments from the Clinch River were selectively leached. Salts between a pH of 6 to 8 removed less than 10% of the ^{60}Co, ^{106}Ru, and ^{137}Cs, though up to 80% of the ^{90}Sr. At lower pH's up to 80% of the ^{90}Sr and ^{60}Co were leached. At higher pH's up to 50% of the ^{106}Ru and up to 20% of the ^{60}Co are released. (auth)

7735 (ORNL-3697(p.222-6)) APPLIED INTERNAL DOSIMETRY. B. R. Fish (Oak Ridge National Lab., Tenn.).

Several employees were counted for indications of $^{90}Sr-^{90}Y$ intake following three separate incidents of suspected exposure. The computer program for processing whole-body count data was made more flexible and can analyze data from about 75% of the routine counts. Computer plotting of in vivo spectra was discontinued as not economical. Several different source-phantom configurations for calibrating the whole-body counter are being studied. (auth)

7736 (ORNL-TM-959) ANALYSIS OF HFIR IRRADIATED FUEL ELEMENT SHIPPING CASK. J. H. Evans,

G. H. Llewellyn, T. W. Pickel, A. E. Spaller, and B. W. Wieland (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 161p. Dep.(mn); $5.00(cy), 3(mn) OTS.

An analysis is presented of the HFIR Element Shielded Transfer Cask loaded with a HFIR core which has been operated for 15 days at 100 Mw(t) and subsequently stored for nine months. The calculated results pertaining to structural integrity, heat removal, fire resistance, and shielding establish compliance with requirements for Bureau of Explosives approval and with criteria stated in the proposed AEC Regulation 10 CFR 72, "Protection Against Radiation in the Shipment of Irradiated Fuel Elements." (auth)

7737 (RFP-451) A STUDY OF TWO COMMERCIAL FILM BADGE SERVICES. J. R. Mann (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Dec. 21, 1964. Contract AT(29-1)-1106. 11p. Dep.; $0.50(cy), 1(mn) OTS.

The services of two film badge processers were evaluated over a 3-month period. Fifty badges from each company were used every 2 weeks, each badge having a beta-gamma and a nuclear track film. Employees working in a Pu chemistry plant wore 80 of these badges, while the remaining 20 were used for calibration. The dose results were received ~19 days after the film was returned, an excessive time for control of exposures. The results showed dose discrepancies from the Dow badges: one company was low in its neutron dose estimation by a factor of 40. Neither company could evaluate beta doses. (D.L.C.)

7738 (TID-21400) A METHOD FOR EVALUATING SURFACE CONTAMINATION OF SOFT BETA EMITTERS. John R. Prince and Chih H. Wang (Oregon State Univ., Corvallis). [1964]. Contract AT(45-1)-1387. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The method of liquid scintillation counting in use at Oregon State University for detecting and evaluating surface contamination consisting of soft betas, especially tritium, is described. The method used is a modification of that originally described by Wang and Jones (Biochem. Biophys. Res. Comm., 1: 203-205 (1959)) for the liquid scintillation counting of paper chromatograms. A surface suspected of being contaminated is swiped with an appropriate filter paper. A section of the paper is cut out, moistened with conventional phosphor solution, and placed directly into a standard vial for counting in a liquid scintillation counter. The counting efficiency for this method has been determined to be greater than 5% for tritium in the absence of severe quenching and greater than 50% for carbon-14. This suggests that the method is adequate for the detection of millimicrocurie quantities of removable surface contamination and appears to be one of the most convenient and sensitive techniques for monitoring tritium. Experimental results are tabulated for a variety of compounds. In view of the simplicity of this method and the fact that it is suitable for the rapid evaluation of large numbers of swipe tests in a counter equipped with both an automatic sample changer and a spectrometer system, it can be recommended for a great variety of applications. (auth)

7739 (UCRL-11700) HEALTH CHEMISTRY PROCEDURES FOR RADIOISOTOPE SAFETY. (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 13, 1964. Contract W-7405-eng-48. 102p. Dep.; $4.00(OTS).

Principles are given for the safe handling of radioactive materials at Berkeley. These principles are arranged into sections dealing respectively with organization for radiation safety, administration of contractual safety obligations, procedures, and radiation incidents. (D.L.C.)

7740 A SIMPLE METHOD FOR TRANSFERRING VOLATILE RADIOACTIVE MATERIALS. Theodore M. Farber (George Washington Univ., Washington, D. C.). Anal. Biochem., 9: 483-4(Dec. 1964).

A method is described for transferring volatile radioactive materials that is simple and rapid and greatly reduced the chance of contamination. The method provides for the alternate introduction of air or of diluent for transferring the radioactive solution quantitatively and effectively washing the ampoule without danger of contamination. (P.C.H.)

7741 STRONTIUM 90 AND CAESIUM 137 IN COW'S FODDER AND MILK IN FINLAND 1961-1962. Esko Lakanen (Agricultural Research Centre, Helinski) and Anneli Salo. Ann. Agr. Fenniae, 3: 157-63(1964).

Strontium-90 and ^{137}Cs contents of fodder, grass, and milk were analyzed. The samples originated from five different places in Finland and represented the activity level in summer 1961 and in the beginning of July 1962. The mean values (^{90}Sr pC/g Ca) were: fodder (1961) 70, grass (1962) 256, milk (1961) 3.2, and milk (1962) 11.3. The mean values (^{137}Cs pC/g K) were: fodder (1961) 31, grass (1962) 88, milk (1961) 22, and milk (1962) 63. The observed ratio for ^{90}Sr from diet to milk gave a mean value of 0.047, which is considerably lower than OR of 0.1 reported elsewhere. A possible explanation is the rather high inactive Sr/Ca ratio of some Finnish plants and milk. (auth)

7742 RADIATION FIELD IN INTERPLANETARY SPACE AND ITS INFLUENCE ON MAN DURING A SPACE-FLIGHT. W. Jacobi (Hahn-Meitner-Institut fur Kernforschung, Berlin). Astronaut. Acta, 10: 105-37(1964). (In German)

The characteristics (composition, flux, energy spectrum) of galactic and cosmic radiation as well as the radiation in the earth's radiation belt are compiled from available data, and their spatial and temporal variation is described. The expected radiation doses in manned space vehicles are estimated, and possible radiation injuries are discussed. It is shown that the greatest dangers are caused by the protons of large solar proton flares and by high-energy protons in the inner radiation belt. Since the inner radiation belt can be avoided, the necessary protection of a manned space vehicle is determined by solar protons. With a shield-thickness of 6 to 8 g/cm^2 it can be expected that the mean whole-body dose during a space flight lasting about 1 month would not exceed 25 rem. Light-atomic, high-hydrogenic materials, for example liquid hydrogen, water or polyethylene, are best suited for shielding. (auth)

7743 THE POSSIBILITY OF USING A LARGE-SURFACE METHANE FLOW COUNTER FOR DETECTING CONTAMINATION IN HUMAN BEINGS. W. G. Rudat and M. W. Stroetges (Universität, Muster, Ger.). Atompraxis, 10: 469-72(Nov. 1964). (In German)

The possibility of using a measuring bench equipped with a large-surface methane flow counter for detecting low-activity surface contamination of human beings in case of a catastrophe was investigated. In spite of changing geometric conditions, the set-up proved to be suitable, since it could detect pure beta sources and gamma emitters with sufficient accuracy and sensitivity. (auth)

7744 EFFECTS OF THE GROUND ON THE γ DOSE FROM DISTRIBUTED ^{137}Cs SOURCES. C. E. Clifford (Defence Chemical Biological and Radiation Labs., Ottawa). Can. J. Phys., 42: 2373-83(Dec. 1964). (DCBRL-442)

The effects on the exposure dose of different ground materials and of a ground cover similar to snow were measured for a smooth surface contaminated with 0.66-Mev γ sources (^{137}Cs). Measurements were made also of the effect of a rough surface on the exposure dose. For uniform contamination of a smooth ground, agreement within 10% was obtained with theoretical dose distributions based on infinite-medium calculations. However, even moderate ground roughness reduced the dose at a detector height of 1 meter by a factor of two below its value for a smooth surface. Failure to specify the effect of ground roughness on smooth field calculations as a function of the surface roughness appeared to be the largest source of error in the calculation of exposure dose. (auth)

7745 RADIATION PROTECTION IN CANADA. PART IV. FACTORS OF IMPORTANCE IN MINIMIZING RADIATION EXPOSURE OF PATIENTS, OPERATORS AND OTHERS INVOLVED IN DIAGNOSTIC AND THERAPEUTIC RADIOLOGY. H. E. Duggan (Univ. of Alberta, Edmonton, Can.). Can. Med. Assoc. J., 91: 893-9(Oct. 17, 1964).

Ways in which the radiation dose to patients, to people working directly with x rays, and to nonoccupational workers in the vicinity of x rays can be reduced are outlined. Some new data are provided on the measurement of the radiation dose to the skin and gonads from diagnostic x-ray procedures. A table gives examples of the entrance and exit doses of radiation and the male and female gonadal doses from some common x-ray examinations. It was found that the male gonadal dose from a posterior-anterior chest film is 0 and the female gonadal dose 9 mr. This contrasts with pelvimetry where the total ovarian dose is 1181 mr. The advantages of several basic measuring instruments are discussed. Favored is a model 570 Condenser R-Meter manufactured by the Victoreen Instrument Co. Another table shows the relation between increasing kilovoltage and entrance dose, exit dose, and gonadal doses. By increasing the kilovoltage from 70 to 110, the entrance dose can be reduced to almost one-half. It was shown that the male and female gonadal doses can be reduced by increasing the kilovoltage from 70 to 90 kv. There is no change in the gonadal dose when the kilovoltage is varied from 90 to 110 kv. The use of relatively high kilovoltage techniques for most radiographic examinations is thus recommended. The patient dose can also be reduced by the addition of an external filter giving a total filtration, inherent plus added filter, of at least 3 mm of aluminum. The exposures on the abdomen with an apparatus which has only the inherent filter with another that has the inherent filtration plus 2 mm of aluminum are compared. In the former, the entrance dose is almost double that of the beam which is filtered and the exit and gonadal doses are considerably increased. Another table shows radiation dosage during fluoroscopy at 3 ma and at 5 ma and their relation to variations in kilovoltage and filtration. It is recommended that for fluoroscopy the kilovoltage be kept relatively high and the milliamperage 3 ma or less. The entrance and exit doses are shown for an individual having a chest radiograph performed on the miniature chest x-ray apparatus. It is possible to reduce this dosage considerably by adding aluminum filtration. Some important considerations in reducing radiologic exposure are: (1) All users of x-ray equipment should be properly qualified; (2) the radiologist should insure that x-ray equipment is safe to operate; (3) the dose of radiation to the patient must be kept as low as possible; (4) all persons operating x-ray equipment should wear film monitoring badges and permanent radiation records should be kept on all occupational workers; (5) all x-ray equipment should be checked at regular intervals by a qualified person and large x-ray installations should have the necessary radiation measuring equipment and qualified personnel to carry out their own dosage measurements and surveys. (BBB)

7746 RADIATION PROTECTION IN CANADA. PART V. RADIOBIOLOGICAL AND RADIOLOGICAL HEALTH RESEARCH IN CANADA. John R. Brown and Anita A. Jarvis. Can. Med. Assoc. J., 91: 1260-5(Dec. 12, 1964).

A recent survey was carried out with respect to radiobiological and radiological health projects in Canada. Letters of inquiry, followed by two questionnaires, were sent out to every institution where radiation research was likely to have been undertaken. Approximately 75% of those contacted replied. Of the total of 200 studies, 84% were classified as biological and medical studies, the remaining 16% as environmental radiation studies. Responses to the inquiry stressed the inadequacy of the present governmental budget for radiation research, the need for higher salaries for research workers, and the necessity of a more intensive teaching program for technicians and professional personnel. The granting of longer-term grants, rather than annually renewable grants, is urged. (auth)

7747 MAXIMUM PERMISSIBLE CONCENTRATION OF Sr^{90} IN FOOD PRODUCTS. V. P. Shamov (Leningrad Scientific Research Inst. of Radiation Hygiene). Gigiena i Sanit., No. 10, 96-104(Oct. 1964). (In Russian)

Analyses of human bone tissues with various accumulations of ^{90}Sr indicated that the maximum permissible level of ^{90}Sr in food can be considerably increased. Data indicate that the maximum permissible concentration for personnel (taken as 2 μC) and for the total population (taken as 0.066 μC) may be increased 4 to 7 folds. (R.V.J.)

7748 THE EXISTING DANGERS OF RADIOACTIVE FALLOUT. Luigi Oliva (Università, Siena, Italy). Minerva Med., 54: 2463-8(Sept. 1, 1963). (In Italian)

Some of the early history of radiology and the mortality of the first workers in radiation is recounted. The process of atmospheric contamination by nuclear explosions is outlined briefly; distinction is drawn between clean and dirty bombs. Two kinds of radioactive fallout are recognized, immediate and delayed; more attention is given to the latter. Descriptions of the decay modes, half lives, and biological concentration of ^{90}Sr, ^{131}I, and ^{137}Cs are given. Descriptions are also given of the pathological reactions of those exposed to the radiation of the Bikini blast of March 1, 1954, particularly the crew of the "Lucky Dragon." Other information of relevance is gathered: the mean life spans of radiologists, as opposed to that of other North American physicians (65.7 years), is 60.5 years. Genetic results of radiation are quoted for laboratory animals, and the male/female ratio of births after the explosions at Hiroshima and Nagasaki is discussed. The extent of radiation released into the atmosphere by bomb tests by the nuclear powers is directed to a brief outline of the radioacitivity level in Italy. (BBB)

7749 RADIO-CONTAMINATED FOODS AND CALCIUM. Shiroh Gotoh. Nippon Koshu Eisei Zasshi, 10: 639-43(Nov. 1963). (In Japanese)

Radiation hazards from fallout contamination in foods by ^{90}Sr and ^{137}Cs in Japan are discussed. The results of a survey show that the Japanese diet is low in Ca, but consideration should be given to the behavior of ^{90}Sr in hard tissues with Ca. (P.C.H.)

7750 ON DEATH AND DEATH SYMBOLISM: THE HIROSHIMA DISASTER. Robert Jay Lifton (Yale Univ., New Haven). Psychiatry, 27: 191-210(Aug. 1964).

Psychologic effects of the atomic bombing on Hiroshima residents were investigated on the basis of individual interviews in 1962 with two groups of atomic bomb survivors. One group of 33 was chosen at random from a list of more than 90,000 survivors. An additional 42 survivors were selected because of their prominence in dealing with atomic bomb problems or their capacity to articulate their experiences (including physicians, university professors, city officials, politicians, writers, and poets, and leaders of survivor organizations and peace movements). The first group includes four groups considered to have had possible exposure to significant amounts of radiation: those who at the time of the bomb were within the city limits, an area extending from the bomb's hypocenter to 4000 m; those who were not in the city at the time, but within 14 days entered an area extending to about 2000 m from the hypocenter; those who were engaged in aid to, or disposal of, bomb victims at various stations; and those who were in utero, and whose mothers were in any of the first three groups. This study attempted to explore the psychological elements referred to as the permanent encounter with death which the atomic bomb created within those exposed to it. Four different stages of experience with death, that is, four aspects of this encounter, are discussed. The overwhelming immersion in death directly following the bombing began with the array of dead and near-dead in the midst of which each survivor found himself. Important here was the extreme sense of surprise and unpreparedness. Anyone exposed relatively near the center of the city could not escape the sense of ubiquitous death around him, resulting from the blast itself, radiant heat, and ionizing radiation. The most significant psychological feature at this point was the sense of a sudden and absolute shift from normal existence to an overwhelming encounter with death. Recall of the experience was extremely vivid, despite the 17-year interval. For those closest to the hypocenter, first memories of the event were frequently only of a sudden flash, an intense sensation of heat, of being knocked down or thrown some distance and finding themselves pinned under debris,

or of simply awakening from an indeterminate period of unconsciousness. Among the initial emotions experienced, many stressed feelings related to death and dying. Beyond this sense of imminent individual death was the feeling of many that the whole world was dying. A deathly silence was consistently reported by survivors. Rather than wild panic, most described a ghastly stillness and a sense of slow motion. Characteristic at this stage was the other-worldly grotesqueness of the scene, the image of neither-dead-nor-alive human figures with whom the survivor closely identified himself. An examination of the further psychological meaning of this early immersion in death demonstrated the importance of feelings of helplessness and abandonment in the face of threatened annihilation. The fear and anticipation of annihilation dominated this phase, though it was not always easy to determine exactly what the hibakusha feared. His anticipation of annihilation (of self, of being, of identity) was related to overwhelming stimuli from without and within, an ultimate sense of threat that has been referred to by such names as basic fear and the fear of the universe. So overwhelming was this experience that many would have been unable to avoid psychosis were it not for a widespread and effective defense mechanism which is referred to as psychic closing-off. In the face of death and near-death, people, sometimes within seconds or minutes, simply ceased to feel. They had a clear sense of what was happening around them, but their emotional reactions were unconsciously turned off. Psychologic reactions of the survivors to the effects of fallout, acute radiation disease, and to latent effects of radiation, appearing years later, are also described. (BBB)

7751 APPLICATION OF STATISTICAL TECHNIQUES TO ENVIRONMENTAL RADIATION SURVEILLANCE. M. A. Wall (Public Health Service, Winchester, Mass.). Public Health Rept. (U. S.), 79: 1057-64(Dec. 1964).

Statistical techniques used to estimate and minimize errors in the determination of radioisotope concentrations in samples such as air, water, milk, selected food items, and various types of biota are reviewed. It was concluded that the degrees of variation in repeated measurements of background and environmental samples on nuclear counting equipment can be minimized by resolving and removing sources of variance peculiar to the particular apparatus. Once under control, optimum operating conditions can be monitored through the use of the appropriate statistical techniques. Application of these techniques to low-level beta counters and gamma spectrometers has confirmed the success of this approach. (P.C.H.)

7752 CONTAMINATION AND DECONTAMINATION OF THE SURFACES OF VARIOUS COATINGS. Yoshiki Wadachi and Shunichi Miyasaka (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 13: 462-4(Nov. 1964). (In Japanese)

The excellent coating surface of hot area has a low susceptibility and a high decontaminability to the radioactive contamination. In order to survey such excellent coatings, 27 species of coatings which are Japanese commercial products were examined to their susceptibilities and decontaminabilities to radioactive isotopes, that is, $^{60}CoCl_2$ and fission products. Also 5 species of floor materials were examined. Results obtained show that some vinyl chloride resin coatings are excellent for the wall surface and some unsaturated polyester resin coatings are suitable for the floor surface of hot area. (auth)

7753 PROGRESS IN DENTAL RADIOLOGICAL HEALTH. James W. Miller (Public Health Service, Washington, D. C.). Radiol. Health Data, 5: No. 10, 499-504(Oct. 1964).

Approximately 100,000 x-ray machines in the U. S. are owned and operated by dentists, who expose approximately 185,000,000 dental films a year. The development of dental x-ray control programs is reviewed and results are summarized from various surveys on the safety of dental x-ray equipment. The scope of inspection programs for dental x-ray equipment of the various states is discussed. It is pointed out that correction of filtration and collimation defects have resulted in a substantial decrease in the contribution of dentistry to the radiation exposure of the population but there is still a sizable potential for exposure reduction through the adoption of improved techniques and equipment. (C.H.)

7754 UTAH DENTAL X-RAY MACHINE SURVEY, 1961–1963. John B. Wheeler (Public Health Service, Washington, D. C.) and Grant S. Winn. Radiol. Health Data, 5: No. 10, 505-10(Oct. 1964).

Dental x-ray machines in use in Utah were surveyed in 1961 and resurveyed in 1962 and 1963. A total of 432 dental installations with 455 x-ray machines was surveyed. Data are summarized on the condition of the x-ray machines, methods used in exposing and developing film, and the radiation exposure to personnel and patients. It was concluded that the surveys were worthwhile from the standpoint of the reduction of unnecessary radiation exposure. (C.H.)

7755 THE QUESTION OF ATMOSPHERIC RADIOACTIVE FALLOUT. Em. Andreev. Rentgenol. i Radiol., 3: 36-41(1964).

The distribution of isotopes and various factors affecting fallout and distribution in surface waters and ground are discussed. (TCO)

7756 THE EFFECT OF COMMERCIAL PROCESSING UNIT OPERATIONS ON THE REMOVAL OF FALLOUT FROM GREEN BEANS (PHASEOLUS VULGARIS). Rudolph William Hirzel. Thesis, Columbus, Ohio, Ohio State Univ., 1964. 87p.

The unit operations of green bean processing are evaluated for their effect upon the reduction of aged radionuclides (fallout). A short and repeatable method of sampling, using a small sample size, is proposed. A literature review is presented on the individual unit operations of bean processing. The important radionuclides occurring in fallout and the problems of sampling and determination of radionuclides are reviewed. The unit operations were duplicated in the laboratory with commercial equipment. The percentages of radionuclides removed by each unit operation are presented. The total amount of radionuclides removed from beans of the 4–6 size was 46.6 per cent; the total removed from beans of the 0–3 size was 34.9 per cent. The difference in the percentage removed was believed to be due to the increased surface area per unit weight of the smaller sized bean. There was no significant difference in the amount of radionuclide removed in the two blanching unit operations, water blanch and steam blanch. At the time of blanching there was no significant difference between the cooled and non-cooled samples. However, a significant difference in radioactivity was found between the cooled and non-cooled samples after canning, freezing, freeze-drying, and dehydrating. Canning, freezing, freeze-drying, or dehydrating had no significantly different effect upon the reduction of the radionuclide level. Three beta emitters were present in the samples of green beans, cesium 137, potassium 40, and strontium 90. The decrease in radioactivity of the samples through all unit operations was due to the removal of strontium 90. On the basis of this study, duplication of unit operations would appear to be the most promising method for the immediate reduction of radionuclides from green beans. (A.G.W.)

7757 PUBLIC HEALTH ASPECTS OF PROTECTION AGAINST IONIZING RADIATION. Report Prepared by the WHO Regional Office for Europe on a Conference Convened by The World Health Organization, Dusseldorf, 25 June–4 July 1962. (Copenhagen, World Health Organization, 1963. 72p. (In English or French)

Seven articles are included on: ionizing radiation as a public health problem; principles of public health in radiation protection; review of existing laws, regulations, and codes of practice; the role of public health radiation protection services; the role of public health services in planning for and dealing with emergencies; qualifications and training of public health personnel in charge of radiation protection services; and health education in the field of radiation protection. (P.C.H.)

7758 CIVIL LIABILITY FOR NUCLEAR DAMAGE. Conference held by the International Atomic Energy Agency, Vienna, April 29–May 19, 1963. Legal Series No. 2. (International Atomic Energy Agency, Vienna). 1964. 536p. STI/PUB/54. $10.00; Sch 210; 60s.std; F.fr. 40; DM 35 (IAEA).

A conference was held to draft a Convention on Minimum International Standards Regarding Civil Liability for Nuclear Damage. Summary records of the plenary meetings and of the meetings of the Committee of the Whole are also given. (D.L.C.)

7759 RADIATION CONTROL IN FLORIDA — POLICIES AND PROCEDURES FOR THE CONTROL OF SOURCES OF IONIZING RADIATION INCLUDING RADIOACTIVE MATERIALS. (Florida State Board of Health. Div. of Radiological and Occupational Health, Tallahassee). Mar. 1964. 108p.

The proposed agreement between the USAEC and the State of Florida for the transfer of certain regulatory authority and responsibility within the state is given. The radiation control program of radioactive materials and radiation machines is described. Licensing, inspection, and enforcement are discussed. Organization, personnel minimum qualifications, and rules of the state board of health are outlined. (D.L.C.)

7760 THE DECONTAMINATION SERVICE AT A.E.R.E. HARWELL. G. W. Clare (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 43p. (CONF-555-11)

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

A short history is given on the development of the decontamination service at Harwell. The early problems encountered are outlined and the first two buildings used for decontamination work are described. The experience gained over 10 years was included in a new center completed in 1962. The design of this building, the finishes, special equipment, plant and services, together with the experiences in operational use, are discussed and illustrated. The policy adopted in the use of sealed areas equipped ventilation and P.V.C. pressurized suits is also covered. In the description of the operations special attention is given to the practical application of decontamination techniques. The operational methods, processes, and chemicals in daily use are mentioned together with the administrative, routine, and Health Physics control. Two examples of dismantling work are outlined, together with a description of the mobile equipment and methods used. Lessons learned in the past two years of operations in the new center are listed. (P.C.H.)

7761 FURTHER STUDIES OF FILM BADGE SENSITIVITY AND ACCURACY. Allen Brodsky (Univ. of Pittsburgh), Albert A. Spritzer, Frederick E. Feagin, et al. 36p. (CONF-642-9).

From Health Physics Society, Cincinnati, June 1964.

Studies were made on noninherent sources of error in personnel monitoring, such as variations resulting from body build and orientation, variations in radiation field geometry, and absolute or fixed errors in interpreting biologically effective doses. Some of the studies of errors in film dosimetry of gamma radiation are summarized, and estimates of the compound errors in individual and population exposures are presented. The advantages of photographic emulsion in personnel dosimetry are listed. (P.C.H.)

INSTRUMENTATION

General

Refer also to abstracts 7619, 8114, and 8401.

7762 (BDX-613-30) PERMEATION OF HELIUM INTO VACUUM TUBES (thesis). John J. Rode (Kansas. Univ., Lawrence). May 1962. Contract AT(29-1)-613. 76p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A mathematical analysis is presented of the diffusion of helium gas through the glass walls of an evacuated (10^{-8} mm Hg) electron tube. The analysis is based upon Fick's model of the diffusion in mechanism. The experimental measurements are accomplished by using the electron tube itself as a vacuum ionization gage. The experimental results are in strong agreement with the developed theory. (auth)

7763 (EUR-1883.i) AUTORADIOGRAFIA QUANTITATIVA. PARTE I. PREPARAZIONE DEGLI STANDARDS RADIOATTIVI A CONCENTRAZIONE SCALARE DI TRACCIANTE. (Quantitative Autoradiography. Part I. Preparation of the Radioactive Standards with Step-Type Concentration of Tracer). L. Matteoli, P. Logi, and S. Salamanna (Istituto di Ricerche Breda S.p.A., Milan). 1964. 20p. Dep.(mn).

Quantitative interpretation of the results of an autoradiographic investigation may be possible if one uses a radioactive calibration source series prepared with isotopes of suitable energy and with known, step-type concentration. Details are given of a method for the preparation of radioactive standard films having uniform, constant thickness; the method is based on the use of photographic gelatin as a support of the tracer, and on a modification of Goldberg's classic method for the preparation of thin gelatin layers with variable thickness for photometric measurements. Details on the following points are reported: basic physico-chemical properties of gelatin; preparation of slides for deposition of the gelatin-tracer solution; selection of lateral inserts, referring especially to the desired thicknesses; choice of suitable tracer concentrations and preparation of radioactive solutions; drying-up and preservation of obtained films; control of thickness and tracer distribution, mounting of standard series and selection of source supports. Some autoradiographies of the obtained standard series and the corresponding photometric traces are included. Finally, a method is described for the preparation of radioactive films having constant concentration and growing thickness ("wedges"), to ascertain the influence of thickness variations on the autoradiographic image blackening for every employed radioisotope. As an example, the autoradiographies of two "wedges" of ^{45}Ca are reported. (auth)

7764 (EUR-2102.e) A SIMPLE DEVICE FOR SERIES TESTING OF PHOTOMULTIPLIER OVERALL GAIN AND CATHODE UNIFORMITY. A. Strub (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 34p. Dep.(mn).

The construction and performance of a device are described which allows one to measure relative gain and cathode nonuniformity of photomultipliers by a simple routine procedure. The device uses two different light sources: (1) A ZnS(Ag) scintillator associated with a rather strong ^{238}Pu source for measuring phototube overall gain. This light source is mounted on a plexiglass cone. (2) Another small (2 mm dia) light source of the same type, but mounted on the periphery of a 20 cm dia aluminum disk which rotates at 1 turn/30 seconds. As the disk is placed very near to the multiplier top, it allows scanning of the photocathode. The multiplier itself can be displaced by a spindle-driven mobile support. Multiplier output impulses are amplified and then averaged in a diode circuit. Thus the relative value of phototube overall gain can be read with an electronic voltmeter. The output signal obtained when scanning the photocathode is recorded with a pen recorder. The curves thus obtained may be used for making three-dimensional sensitivity diagrams. (auth)

7765 (IDO-17029) SOME USES OF TIME OF FLIGHT TECHNIQUES IN CONJUNCTION WITH A NEUTRON CRYSTAL SPECTROMETER. R. R. Spencer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 1964. Contract AT(10-1)-205. 18p. Dep.; $1.00(cy), 1(mn) OTS.

A Fermi type rotor was used in conjunction with the MTR neutron crystal spectrometer as a means of separating the various orders of Bragg reflection. By chopping the spectrometer Bragg neutron beam and by time-of-flight analyzing the resulting neutron bursts, it was possible to eliminate order effects in neutron transmission measurements, to observe the many high order reflections in a mica crystal, and to observe the "forbidden" Be(001) reflection which is simulated by multiple scattering of Umweganregung. (auth)

7766 (IFA-MR-21) ON THE METROLOGICAL PARAMETERS IN THE MEASURING OF MOISTURE. I. Apostol and M. Oncescu (Academia R. P. R. Institutul de Fizica Atomica, Bucharest). 1964. 12p. Dep.(mn).

The metrological characterization of moisture measuring equipment, in situ, by neutron scattering is discussed. A method is suggested for determining the threshold of sensitivity and the precision of such equipment. From the calibration curve, one determines the sensitivity and hence the precision error. It is shown that the precision error contains a statistical error, a fidelity error, and a calibration error, and the means of experimental determination of these errors is pointed out. Since the metrological parameters depend both upon the moisture content and upon the counting time, equipment for moisture measuring should be characterized by curves that show the dependency of the threshold of sensitivity and of imprecision on the above factors (moisture content and counting time), rather than by single values. The suggested method is applied to two types of portable equipment, a surface-type and a probe-type, conceived for the moisture measurement of loess. Finally the advantages of knowing the dependency of the metrological parameters on moisture, are discussed in view of designing such equipment. (auth)

7767 (IFA-MR-24) DETERMINATION OF THE HYDROGEN CONTENT FROM MATERIALS BY MEANS OF NEUTRON SOURCES. I. Apostol and M. Oncescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest). [1964]. 13p. Dep.(mn).

A radiometric installation is described for the determination of the hydrogen content, such as in moisture in sand. The determination is based on the slowing-down of fast neutrons, and surface and depth meter variants of the installation are described. The calculation of the sensitivity and precision of the measurements is discussed. (D.L.C.)

7768 (IS-1046) AuFe VS Cu THERMOCOUPLES. D. K. Finnemore, J. E. Ostenson, and T. F. Stromberg (Ames Lab., Ames, Iowa). Nov. 1964. Contract W-7405-eng-82. 12p. Dep.; $1.00(OTS).

The thermoelectric voltage of Au–0.07 at. % Fe vs Cu was measured at 2.0 to 77°K and found to be linear over much of the temperature range. The sensitivity ($\mu v/°K$) is plotted vs temperature and compared with that for Au–0.02 at. % Fe. The use of Au–Fe thermocouples to measure low temperatures is suggested. (D.L.C.)

7769 (NYO-3124-1) FABRICATION OF SEMICONDUCTOR DEVICES BY NEUTRON TRANSMUTATION DOPING. Annual Report, December 1962–December 1963. Carl N. Klahr and Melvin S. Cohen (Fundamental Methods Associates, New York). Dec. 31, 1963. Contract AT(30-1)-3124. 178p. Dep.; $5.00(OTS).

Progress is reported in the development of a new process for fabrication of semiconductor devices and microcircuits within a nuclear reactor. Thermal neutron

reactions with the semiconductor material produce electronically active doping materials at the desired spatial locations within the semiconductor by a transmutation reaction. Experiments are described in which the principle of this concept was proved by fabrication of operational electronic devices in Si using the Oak Ridge Reactor as the irradiation source. Analytical methods are given for designing simple semiconductor devices with p-n junctions by this method. A detailed quantitative analysis is given for the characteristics of the p-n junction devices produced. (auth)

7770 (SC-DC-64-1433) THERMAL DETECTION METHOD FOR EXTREME ENVIRONMENTS. First Quarterly Progress Report, April 1, 1964–June 30, 1964. (Marquardt Corp., Van Nuys, Calif.). For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The objective of this program is to develop a method for detecting the thermal energy of extreme environments resulting from aborted missile and aerospace rocket launchings. The temperatures to be investigated range from 1500°F to 6000°F for approximate time intervals of 60 minutes (at 1500°F) to 0.5 seconds (at 6000°F). Additional environmental conditions include chemicals from the vehicle's propulsion system in both reacted and unreacted conditions and a pressure shock wave of 10,000 psi. The method is to utilize a non-instrumented device containing one or more materials systems. The materials systems shall produce irreversible transformations by a mechanism that can be calibrated to provide data on the total thermal energy experienced. Diffusion is a major mechanism under consideration. It was initially planned to induce microstructural changes in cold worked refractory metals such as tungsten and tantalum. Study to date indicates the sensitivity of the diffusion approach will be substantially increased by the use of radioactive isotopic diffusion elements in conjunction with microautoradiographic detection techniques. Nickel-63 appears to be the best isotope for this method. The evaluation of thermal energy by weight loss measurements with graphite or similarly degradable materials has been dropped from further consideration. This was necessary when the program was modified by the inclusion of chemical environments due to various propellant systems. Material systems that are sensitive to slight variations of the chemical environments cannot produce accurate data. (auth)

7771 (SC-TM-64-1714) OPTICAL CRYOSTAT FOR USE WITH BEAM CONDENSERS. R. S. Neiman (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract [AT (29-1)-789]. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The design of a small cryostat base for use with such equipment as the beam condensers for Beckman infrared spectrophotometers is presented. (auth)

7772 (SGAE-PH-9/1964) RESULTS ON A NEW ELECTROSTATIC TIME-OF-FLIGHT MASS SPECTROMETER DEVELOPED AT THE REACTOR CENTER SEIBERSDORF. M. J. Higatsberger, F. P. Viehboeck, F. Rudenauer, and F. Buschbeck (Osterreichische Studiengesellschaft für Atomenergie G.m.b.H. Physik-Institut, Seibersdorf). Aug. 25, 1964. 43p. Dep.(mn).

A new type of an electrostatic r-f time-of-flight mass spectrometer is described, which employs parabolic flight paths for energy selection. Mathematical treatment of such a system is given. Details on the analyzer and the electronic circuit of a prototype instrument are reported. First experimental tests were performed and the obtained results are in good agreement with theory. (auth)

7773 (TID-21338(p.172-81)) DESIGN OF A SIMPLE TUNNEL-DIODE STEP GENERATOR. James Oleson (Johns Hopkins Univ., Baltimore).

Design studies for a square-wave generator having a rise time of about 200 psec are reported. (T.F.H.)

7774 (UJV-1092/64) ČASOVÝ BLOK PRO MNOHOKANÁLOVOU ANALYSU. (Time Module for Multichannel Analyses). B. Malý and F. Duda (Ceskoslovenská Akademie Ved. Ustav Jaderného Výzkumu, Řež). [nd]. 10p. Dep.(mn).

A time module is developed that is an apparatus for obtaining a series of impulses proportional in number to the time of arrival of the measured pulse. It is used as a part of a multichannel time analyzer. For its function it is essential to have a chronometer, determining the delayed start of the analysis and establishing the time axis. That time axis with switched frequencies of 1 Mc, 100 kc, and 10 kc can be divided out in binary manner (1, 2, 4, 8) in the time module. The width of the channel is thus optional and can be 1, 2, 4, 8, 10, 20, 40, etc., up to 800 μs. The number of channels can be 128, 256, 512, or 1024 in accordance with the memory selected. For an analysis, the memory, which can be either parallel (e.g., ferrite) or serial (e.g., magnetostrictive), must be serial with a dead time not exceeding the time of 1 cycle. The time module makes possible the simultaneous analysis from up to eight detectors, as long as the time interval of measurement is identical. With the 1024-channel memory, it serves as 8 congruent 128 channel analyzers. The apparatus is fully transistorized and uses printed circuits. The time module does not have its own read out; its correct operation is controlled by the chronometer. (TTT)

7775 THE IMAGE INTENSIFIER. H. Etter (Roentgenabteilung des Kantonsspitals, Luzern, Switzerland). Schweiz. Med. Wochschr., 93: 1077-80(1963). (In German)

Compared to ordinary fluoroscopy, visualization with the image intensifier has the advantages of shorter adaptation time, smaller x-ray dose, increased brightness, and better detail recognition. The principle of the image intesifier is that the x rays emerging from the patient impinge upon a finely beaded fluorescent screen in an evacuated tube, causing electrons to be released from an adjacent photocathode tube. These are focused in an electric field onto an anode. There is ~3000-fold intensification of the image. The small, bright, contrasting, fine-grained image is viewed through a lens. In recent years it has been possible to increase the image size from 13.5 to 23 cm. In place of the binocular viewer, mirror optics, television, and cinematography have also been added. However, with all of these improvements it still has a disadvantage of some loss of details. Resolving power in lines/cm amounts to 12.5 for normal visualization without an image intensifier, but an intensifier with a binocular lens can increase resulution to 35 lines/cm. The contrast is improved with a television monitor so much that the image can be observed in a brightly lighted room, even though the resolution is only 14 lines/cm. The smallest dia of lines that can be discerned with these three methods is 0.40, 0.16, and 0.36 mm, respectively. The smallest dia or depth of areas that are definable under these conditions are 4.5, 1.6, and 1.6 mm, respectively. A small image intensifier with viewing lens is very suitable for examination of the skeleton, and for studies with contrast media. Small pulmonary shadows are easily recognized and differentiated. A large image intensifier with television is required in order to ascertain the form and position of the heart and pulmonary shadings within the thorax. Visualization of the gastrointestinal tract in the small format produced with the image intensifier is not a disadvantage for experienced workers because of the added advantages of increased brightness and improved recognition of details. (BBB)

7776 ON THE GENERATION OF INTENSE FAST-RISING MAGNETIC FIELD PULSES. Brian John Elliott. Thesis, Stanford, Calif., Stanford Univ., 1964. 111p.

Ways and means of switching intense magnetic fields in the nanosecond fractional nanosecond time domain are described. The method adopted for generating the fields is to pass a fast-rising transient current through a coil. Physical limitations of the method are discussed and the following associated topics are treated in detail: energy storage in transmission lines and the influence of line losses on the pulse shape produced by discharging lines; high voltage switching using multiple spark gap techniques that enable tens of kilovolts to be switched in a fraction of a nanosecond; methods of predicting the performance of pulsing systems; a macroscopic theory developed to describe the dominant properties of the spark gaps with respect to their switching speeds and the waveforms produced by cir-

cuits involving gaps; and methods of measuring the fast field, voltage, and current waveforms of the pulsing system, including a procedure that corrects for the limited time response of the viewing oscilloscope. The experimental results show that magnetic fields can be generated, which have an average initial rate of growth of 10^{12} oersteds per second. Recent developments predict the possibility of initial rates greater than 10^{13} oersteds per second. The latter growth rate is adequate for the application of high-peak-power-output ferrite generators. (Dissertation Abstr., 25: No. 2(Aug. 1964))

7777 A SYNTHESIS METHOD FOR THE DESIGN OF ION PROPULSION GUNS. David Smedley Colburn. Thesis, Stanford, Calif., Stanford Univ., 1964. 158p.

In the design of electron or ion guns two general approaches may be used. An electrode configuration may be proposed, based on a reasonable extrapolation of a known gun design. This configuration may be analyzed to obtain the beam and to determine how well this beam meets the specifications set upon it. Alternatively, in the synthesis approach, a flow meeting the specifications is first determined, after which the electrodes required to produce the flow may be determined by known methods. The gun design problem is then defined to be the mathematical determination of the physically realizable flow which best meets the specifications placed upon it. A synthesis method of gun design is developed, which may be used for all laminar axisymmetric flows. In this approach, the beam requirements are included in the specification of one beam trajectory, by naming two of the following three quantities: its shape, incremental beam thickness, or potential profile. This trajectory determines a unique space-charge limited laminar flow by serving as the boundary conditions for the partial differential equations of flow. The flow may be found to the first order of accuracy using the paraxial ray equation and a power series development. A higher order synthesis method is derived, determining the beam to higher orders of accuracy, with equations given for the third order. For a given accuracy requirement, the higher order method is superior to the first order method by allowing the determination of a thicker beam. The solution in the emitter region must be obtained by power series. The trajectories are then found by integration of the partial differential equations, in a mixed boundary value problem. The edge trajectory, analytically continued, provides the boundary conditions for the determination of electrodes. The synthesis method is applied in the design of an ion propulsion gun, such as might be used to propel a space vehicle. (A.G.W.)

7778 ENERGY DISTRIBUTION OF IONS FORMED IN THE RF SPARK SOURCE. II. INDIVIDUAL SPECIES. J. Rogers Woolston and Richard E. Honig (RCA Labs., Princeton, N. J.). 21p. (CONF-649-21)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

The energy distribution of individual ion species produced in a r-f spark source using materials such as metals, semiconductors, compounds, and alloys was studied. Energy spreads range generally from about 2000 to 3000 volts, and for a given material the energy spread increases with r-f spark voltage. Considerably narrower energy spreads (<1000 volts) were observed for both positive and negative ions from silver bromide. The energy spreads and the locations of the distribution maximum for individual components of a given sample are discussed. (auth)

Radiation Detection

Refer also to abstracts 7219, 7269, and 7737.

7779 (AD-419910) LOGISTICAL ASPECTS OF RADIOLOGICAL MONITORING INSTRUMENTATION. Frederick DeBoom Witzel (Stanford Research Inst., Menlo Park, Calif.). Apr. 1963. Contract OCD-OS-62-135. 118p. $10.00(OTS).

This study is an analysis of the logistical problems of requirements planning, procurement, maintenance, storage, calibration and inspection of existing radiological monitoring instruments in the radiological monitoring system and the community shelter program. Emphasis is placed on methods and procedures to improve the operational readiness of this equipment. (auth)

7780 (AED-C-21-02) DOSIMETRY. BIBLIOGRAPHIES. Chemical and Solid State Dosimetry. Klaus Becker (Kernforschungsanlage, Jülich, Germany). Aug. 1964. 203p. Dep.(mn).

References are presented on topics relevant to radiation dosimetry: irreversible radiation effects on gases, liquids, and solids; scintillation counting; calorimetry; etc. The literature up to the end of 1963 is covered. Author, report, and subject indexes are included. (D.L.C.)

7781 (AERE-R-4686) THEORETICAL STUDY OF THE RUBBINO PROTON RECOIL SPECTROMETER, FOR MEASURING NEUTRON ENERGY SPECTRA. J. R. Keane (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Nov. 1964. 28p. Dep.; $0.80(BIS), 4s.(HMSO).

The efficiency and energy resolution of a Rubbino proton recoil spectrometer, for measuring neutron energy spectra from standard sources and accelerator targets, have been calculated for various values of the design parameters. The calculated efficiency is in agreement with experiment. The useful lower energy limit is shown to be about 2 Mev. At higher energies a device of good resolution (5%) is practicable by careful choice of parameters, but the efficiency is low (0.4×10^{-6}% at 4.5 Mev, including source-counter geometry). Advantages of the spectrometer are simplicity of interpretation of spectra and lack of response to gamma-ray background. (auth)

7782 (CERN-64-49) TESTS OF A METHOD TO STUDY HIGH-ENERGY NUCLEAR FISSION BY MEANS OF MICA DETECTORS. PART I. R. Brandt, Ch. Gfeller, and J. Zakrzewski (European Organization for Nuclear Research, Geneva). Dec. 4, 1964. 15p. Dep.(mn).

Sheets of natural mica interleaved with metal foils have been exposed at the CERN proton synchrotron to large doses of high-energy protons in order to test a method of studying high-energy nuclear fission. After processing, the mica sheets were examined under an ordinary optical microscope. It was found that the passage of the high-intensity proton beams through the mica did not affect its registration properties. The application of mica detectors in experiments of this kind may, however, be limited by the background of tracks produced in the mica itself. This background is tolerable for beam densities not exceeding about 10^{13} protons/cm^2. (auth)

7783 (GPI-57) PROGRESS ON A FAST-DRIFT METHOD FOR MAKING LITHIUM-ION-DRIFT GERMANIUM p-i-n GAMMA-RAY SPECTROMETERS. A. J. Tavendale and I. L. Fowler (Atomic Energy of Canada Ltd. Chalk River Nuclear Labs., Chalk River, Ont.). Apr. 1964. Revised and Re-issued Nov. 1964. 10p. (AECL-2110). Dep.; $0.50(AECL).

A fast boiling-liquid method, used to drift large-volume (6 cm^3), deep-depletion-layer (up to 11 mm), p-i-n germanium diodes for use as high-resolution gamma spectrometers is described. The method is about five times as fast as that obtained in an air-drift apparatus. (auth)

7784 (LNF-64/46) CONSTRUCTION AND OPERATION OF A SINGLE-GAP SPARK CHAMBER. R. Habel, T. Letardi, and R. Visentin (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratori Nazionali, Frascati). Sept. 15, 1964. 10p. Dep.(mn).

A single-gap spark chamber was developed for the detection of charged particles. Some observations with neon and helium gases are reported. (D.L.C.)

7785 (MLM-1202) DETERMINATION OF COINCIDENCE CORRECTIONS IN A PROPORTIONAL COUNTER. II. THE KNOWN HALF-LIFE METHOD. H. W. Kirby and J. Z. Braun (Mound Lab., Miamisburg, Ohio). June 1,

1964. Contract AT-33-1-GEN-53. 16p. Dep.; $1.00 (OTS).

Resolution time values computed from the observed counting rates of a rapidly decaying radioisotope are highly sensitive to the method of weighting the data, to the accuracy with which the assumed half life is known, to the counting range used in the determination, and to the validity of the expression used for converting observed counting rates to true counting rates. Half-life computations are usually based on the assumption that the resolution time is known exactly, whereas it is, in reality, very imperfectly known. The probable errors assigned to such determinations do not reflect the uncertainty in the resolution time, and the reported half life is consequently less accurately known than the probable error would imply. (auth)

7786 (NDL-TM-16) A CALIBRATION OF THE US ARMY NUCLEAR DEFENSE LABORATORY'S NEUTRON-DETECTION SYSTEM. John H. McNeilly (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Oct. 1964. 31p.

Results are presented of the complete calibration of the US Army Nuclear Defense Laboratory's threshold foil neutron-detection system and its associated counting equipment. Two independent counting facilities are used with this neutron-detection system; one counting system consists of four manually operated scintillation counters and a gamma-gamma coincidence spectrometer, and the other counting system consists of six automatic scintillation counters. Calibration numbers are presented for each neutron detector when analyzed on each counting system. (auth)

7787 (NYO-3246-3) PROTON AND ELECTRON IRRADIATIONS OF CONTOURED SEMICONDUCTOR RADIATION DETECTORS. J. B. Trice, G. C. Huth, H. E. Bergeson, and R. A. McKinney (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). [1964]. Contract AT(30-1)-3308. 45p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Irradiations of surface contoured silicon semiconductor detectors with monoenergetic beams of low energy electrons (45 kev) and protons from 100 kev to 3.0 Mev are described. Superior noise characteristics, energy resolution, stability, and freedom of these detectors from surface breakdown (the most common difficulty with solid state detectors) are discussed in terms of fundamental electrical properties. Two specific classes of detectors are described. The first of these is a windowless detector in a shallow-cone geometry oriented so that low energy particles from above are incident over a large fraction of the lateral surface. The response of this detector to low energy protons and electrons is described. The second detector described is the proportional solid state detector the operation of which depends on the attainment of very high bulk electric fields. Its response to protons up to 3.0 Mev is described. (auth)

7788 (RT/CHI(64)-26) USE OF THE FERROUS SULFATE CHEMICAL DOSIMETER TO DETERMINE THE BREMSSTRAHLUNG RADIATION INTENSITY IN THE ENERGY RANGE 0.3 TO 1 Gev. F. Salvetti, H. de Carvalho, V. di Napoli, and F. Dobici (Italy. Comitato Nazionale per l'Energia Nucleare, Rome). Sept. 1964. 13p. Dep.(mn).

The use of the ferrous sulfate dosimeter in the energy range of 0.3 to 1 Bev is proposed. The linearity range of dosimeter and the comparison between its response and that of Wilson quantameter are also described. (auth)

7789 (TID-21338(p.168-71)) A SIMPLE TEST FOR THE OPERATION OF A LYMAN-α COUNTER. D. A. Goldberg (Johns Hopkins Univ., Baltimore).

A technique is described for determining the state of operability of a Lyman α detector. The method consists of correlating the detector response with the intensity of a pulsed electric discharge in hydrogen. (T.F.H.)

7790 (TID-21338(p.193-8)) A COUNTER FOR DIFFERENTIATING ELECTRONS FROM PIONS. S. S. Hertzbach, R. W. Kraemer, L. Madansky, and R. A. Zdanis (Johns Hopkins Univ., Baltimore).

An efficient "shower detector" is described that acts as a total absorption counter for electrons, while being relatively insensitive to pions and other strongly interacting particles. The system also measures the electron energy with fair resolution, and provides a uniformly high geometric detection efficiency. The detector consists of a sandwich of ten sections. Each section consists of 5 Pb sheets sandwiched with 5 phosphor sheets. (T.F.H.)

7791 THE USE OF PROPANE AS A COUNTING GAS IN GAS FLOW COUNTERS. H. Behrens and R. Nink (Institut für Wasser-, Boden-und Lufthygiene, Forschungsstätte für Allgemeine Hygiene und Gesundheitstechnik, Berlin-Dahlem). Atompraxis, 10: 467-9(Nov. 1964). (In German)

Comparative investigations were made of methane and propane as counting gas in gas flow counters. In comparison to methane, propane was found to be cheaper and easier to obtain. It was very applicable for measurement of beta particles and gamma radiation, but only limited in its use for alpha counting. Propane had a smaller gross weight. In the counters, with one exception, both the counting gases could be loaded with steam at room temperature up to saturation. In this way it was possible to measure hygroscopic preparations without a window. (auth)

7792 EXPERIMENTAL INVESTIGATION OF THE NM-64 NEUTRON MONITOR. C. J. Hatton and H. Carmichael (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 2443-72(Dec. 1964). (AECL-2094)

A comprehensive experimental study was made of the NM-64 neutron monitor. The counting rate was measured as a function of the thickness of the reflector, of the separation of the counters, of the thickness of the inner moderator, and of the gas pressure in the counters. It is shown that the figures given in the internationally approved specification represent a satisfactory optimization of the design. The counting rate of the NM-64 monitor is found to be 3.3 times that of an IGY monitor of the same horizontal area. The origin and movement of both fast and thermal neutrons within the monitor were investigated using cadmium sheets and by studying events producing counts in more than one counter. (auth)

7793 EVALUATION OF PERSONNEL FILM BADGES USED FOR OCCUPATIONAL RADIATION EXPOSURE. Donald F. Menker and Maxwell Dauer (Univ. of Miami, Fla.). Ind. Med. Surg., 33: 499(July 1964).

The use of photographic film as a radiation personnel dosimeter in work with x rays and radioactive materials is discussed. It is extensively used as an indicator of occupational exposure to ionizing radiation, and the film badge is usually the only means for recording the amount of radiation that the person wearing it has received. As such, the film badges must be reliable and uniform; one type of film badge dosimeter should be in essential agreement with another type of film badge in order for these dosimeters to be a valid and dependable record of personnel exposure. Many variables such as differences in films, filtration, reading, and calibration may modify the final record of radiation exposure dose. Many of these factors cannot be controlled uniformly at all times. Thus, gross errors may enter into the reported exposure dose. Film badges from various commercial companies offering a film dosimetry service were exposed to doses of x rays, γ, and β radiation simulating actual conditions. The badge was returned to the company from which it was obtained for the exposure report. A study was undertaken to determine the reliability, uniformity, and degree of agreement between personnel film badges furnished by different companies. (BBB)

7794 STEADY-STATE RESPONSE OF SILICON RADIATION DETECTORS OF THE DIFFUSED p-n JUNCTION TYPE TO X RAYS. I. PHOTOVOLTAIC MODE OF OPERATION. Karl Scharf and Julian H. Sparrow. J. Res. Natl. Bur. Std., 68A: 683-701(Nov.-Dec. 1964).

A relation is derived for the photocurrent produced by x rays in silicon radiation detector cells of the p-n junction type, giving the dependence of the generated photocur-

rent on exposure rate, photon energy, and electrical and geometrical parameters of the silicon wafer. Silicon radiation detector cells operated as photovoltaic cells are found to be more sensitive to x rays than silicon solar cells previously investigated, open-circuit voltages being several hundred times larger than those measured in solar cells. The short-circuit current produced by x rays increases with increasing temperature by about 0.3 percent per °C at 25°C cell temperature. Due to the high zero voltage junction resistance of silicon radiation detector cells, the temperature dependence of the photovoltaic output current increases with increasing load resistance at a smaller rate than that observed in silicon solar cells. The energy dependence of the short-circuit current produced by x rays, measured over a wide range of radiation qualities, is shown to be in good qualitative agreement with calculated values. (auth)

7795 INTERCOMPARISON OF HIGH-ENERGY X-RAY INTENSITY MEASUREMENTS. John S. Pruitt and Steve R. Domen. J. Res. Natl. Bur. Std., 68A: 703-7 (Nov.-Dec. 1964).

The sensitivity of the NBS P2-4 ionization chamber and a replica of Wilson's Quantameter is compared. The sensitivity ratios are used to compare calorimetric measurements of total x-ray beam energy made at the NBS and in the USSR between 20 and 90 Mev. The agreement is within the combined errors, but the source of an apparent 2% systematic difference was not found. (auth)

7796 NUCLEAR MAGNETIC DOUBLE RESONANCE APPARATUS FOR CHEMICAL SHIFT MEASUREMENTS ON ^{13}C. J. H. Allen (Imperial Chemical Industries, Ltd., Manchester, Eng.), J. K. Becconsall, and D. W. Turner. J. Sci. Instr., 41: 673-5(Nov. 1964).

A method is described whereby ^{13}C nuclear magnetic resonance spectra are measured indirectly, by observing the effects of proton–^{13}C double resonance on the 100 Mc proton spectrum. The ^{13}C resonance frequency is generated from the proton resonance oscillator of the nuclear magnetic resonance spectrometer by frequency division and multiplication followed by modulation. Chemical shifts of ^{13}C nuclei at their natural abundance can be measured with a reproducibility to ±2c (±0.08 parts per million). (auth)

7797 A DOSE MONITOR FOR IRRADIATION EXPERIMENTS ON REACTOR FUELS AT HIGH TEMPERATURE. S. A. Nyboe and P. Barr (Atomic Energy Establishment, Winfrith, Dorset, Eng.). J. Sci. Instr., 41: 691(Nov. 1964).

A cobalt monitor for thermal neutrons is described, suitable for measuring doses in the range $10^{20}-10^{21}$ neutrons per cm^2, which is capable of operating at temperatures in the region of 1500°C and which is easily recoverable using standard apparatus in a high activity handling cell. (auth)

7798 FRACTIONATION EFFECTS IN THE GAS SUPPLY OF FLOW PROPORTIONAL COUNTERS. R. Jenkins (M.E.L. Equipment Co., Ltd., London). J. Sci. Instr., 41: 696-7(Nov. 1964).

The instability and loss of count rate found in gas flow proportional counter-pulse-height analyzer systems when supply gas bottles are almost empty, are shown to be due to shifts in the amplitudes of pulses leaving the counter. The dependence of pulse amplitude on ionizable to quench gas proportions is demonstrated and this in turn is correlated with differences in gas compositions found in full and almost empty supply bottles. (auth)

7799 EFFICIENCY AND TRANSPARENCY OF CHEAP LIQUID SCINTILLATORS. J. C. Barton, A. Crispin, and M. Slade (Northern Polytechnic, London). J. Sci. Instr., 41: 736-9(Dec. 1964).

The characteristics of various liquid scintillators were determined under conditions such that their performance in very large counters can be predicted. Mixtures based on medicinal paraffin are found to be highly transparent with effective attenuation lengths of nearly 2 meters. The addition of Shellsol A, acting as a secondary solvent, can give a scintillation efficiency about half of the best toluene based scintillators, with greater stability and freedom from fire hazard. (auth)

7800 ROUTINE ABSOLUTE ALPHA AND BETA COUNTING IN A 4π PROPORTIONAL COUNTER. Mary L. Curtis (Monsanto Research Corp., Miamisburg, Ohio). J. Sci. Instr., 41: 755-8(Dec. 1964). (MLM-1222J)

A method for absolute alpha and beta counting of samples mounted on metal foil in a 4 π proportional counter is described. Mathematical expressions are presented for determining the 4 π disintegration rate, backscattering contribution, and absorption factors for forward and scattered radiation. Useful scattering and absorption data are obtained and because of the ease of the technique, samples can be counted on a routine basis. (auth)

7801 SOME REMARKS ON THE ORIGIN AND ELIMINATION OF BACKGROUND CLOUD IN EXPANSION CLOUD CHAMBERS. G. R. Evans, N. E. Fancey, J. R. Norbury, and A. A. Watson (Univ. of Edinburgh). J. Sci. Instr., 41: 770-2(Dec. 1964).

Experiments with two high-pressure and two low-pressure Wilson expansion chambers are described in which it was found possible to operate without cleaning expansions, provided no expansion larger than that necessary for ionic condensation was allowed to take place. When expansions are larger than necessary for ionic condensation, it is suggested that re-evaporation nuclei are produced and cause background cloud. A mechanism for the formation of the re-evaporation nuclei is proposed. (auth)

7802 A SYSTEM FOR NEUTRON-DOSE WARNING AND MEASUREMENT. E. Tschirf (Osterreichische Hochschule, Vienna). Kerntechnik, 6: 463-6(Oct. 1964). (In German)

The dosimeter described was designed to be a warning and control device for neutrons. Therefore it will be used only when there is any suspicion of a neutron dose received. It can be determined by simple procedures whether or not the dosimeter has picked up a neutron dose. It consists of four detectors by which 100 mrem can be indicated with only small dependence on the neutron direction. (auth)

7803 P-N JUNCTION SEMICONDUCTOR RADIATION DETECTOR. Junji Shimizu, Kyoichi Miyashita, Mamoru Takada, and Yoshiyuki Sugawa (Mitsubishi Electric Corp., Hyogo Prefecture, Japan). Mitsubishi Denki Lab. Rept., 4: 495-503(Oct. 1963).

Semiconductor radiation detector of the p-n junction type is an attractive detector having many outstanding features. Using a 5,000 Ω-cm p-type silicon crystal, many detectors of the same size (4 × 4.5 mm) are manufactured and tested. The best energy resolution obtained is 0.7% for 5.3-Mev α particles. Measurable upper energy limit of the α particles is tested by scattered α particles from carbon nuclei. The measured limit is 23 Mev, but it may be expansible up to 28 Mev using a detector applicable 200 v bias. As for the optimum energy resolution and charge collection efficiency, two types of detectors having an opposite inclination for the applied bias were found. Measurement of internal conversion electron of ^{57}Co was attempted but two peaks corresponding to 115 and 129 kev were not separated. Detection of thermal neutrons is possible using a boron converter. (auth)

7804 ENERGY LOSS IN SEMICONDUCTORS SEEN CAUSING SIGNIFICANT PROBLEMS. Harold L. Davis. Nucleonics, 23: No. 1, 72-3(Jan. 1965).

A new experiment confirmed the directional dependence of energy lost by energetic ions penetrating single silicon crystals-i.e., ions traveling in preferred directions in the crystal lattice lose less energy than would be predicted by the usual ionization-loss formula. The result indicates that the anomalous-energy-loss effect is more complicated than previously believed. It is suggested that the ultimate solution would be for crystal manufacturers henceforth to slice all thin crystals at the recommended orientation. (P.C.H.)

7805 REGISTRATION OF PARTICLE TRACKS IN A HIGH-PRESSURE STREAMER CHAMBER FILLED WITH HELIUM. I. V. Falomkin, M. M. Kulyukin, D. B. Ponte-

corvo, and Yu. A. Sherbakov (Joint Inst. for Nuclear Research Lab., Moscow). Nuovo Cimento (10), 34: 1394-6 (Dec. 1, 1964).

The possibility of obtaining particle tracks in a streamer chamber at high pressures was investigated, to obtain effective recording of particles stopping or interacting in the gas volume. Two chambers, cylindrical and rectangular, were used. The steel high-pressure device, electrodes, high-voltage pulse source, and G-M-telescope high-voltage trigger are described. Pressure effects on the operating field gradient, the time delay, and the average number of streamers produced per unit length were studied at 4.5 and 6 atm. (M.J.T.)

7806 COLLIMATOR EFFICIENCY AND DESIGN. I. COLLIMATOR EFFICIENCY. A. D. Rotenbert and H. E. Johns (Ontario Cancer Inst., Toronto and Univ. of Toronto). Phys. Med. Biol., 10: 51-65(1965).

The factors influencing the response of a collimator for radioisotope scanning are carefully defined and analyzed. The penetration of radiation through the collimator was taken into account and its more complicated effects evaluated by the use of a digital computer. Experimental work was carried out to assess the accuracy of the results concerning minimum collimator length and septa thicknesses required for a wide range of photon energies. The results are the basis for the solution of some practical problems of collimator design to be given later. (auth)

7807 AN EXPERIMENTAL DETERMINATION OF THE OVERALL SPATIAL RESOLUTION OF A SCINTILLATION CAMERA. T. D. Cradduck and Sylvia O. Fedoruk (Univ. Hospital, Saskatoon, Can.). Phys. Med. Biol., 10: 67-76(1965).

An experimental method is described to assess the spatial resolution of the crystal, light pipe, and photomultipliers of a scintillation camera. This resolution may then be related to the overall resolution of the whole system, including the collimator and display system. The same experiment yields results that may be related to the distortion of the image and shows that the source of most of the lack of spatial resolution is the Gaussian spreading of coordinate pulses in the photomultipliers. On a theoretical basis the introduction of ratio rather than difference circuits will considerably improve the linearity, sensitivity, and resolution. (auth)

7808 A SIMPLE SAMPLE CHANGING MECHANISM FOR AN AUTOMATIC GAMMA SCINTILLATION COUNTER. J. R. Kemplay (London Univ.). Phys. Med. Biol., 10: 77-80(1965).

A sample changing mechanism, incorporating a through side hole crystal assembly, is described for an automatic gamma scintillation counter. The simple mechanics employed offer a fast sample changing cycle with a high degree of safety when glass sample vials are used. The effect of a very active sample upon radiation background is discussed. (auth)

7809 TRANSISTORIZED RADIATION MONITOR. M. J. McHugh (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 10: 107-8(1965).

A portable radiation monitor used in a hospital for the routine monitoring of hospital waste, soiled laundry from the wards, and incinerator residues, before removal from the hospital, is described. The instrument is light, gives both visual and aural indication of counting rate and is designed for single-handed operation. This leaves one hand free for the operator to manipulate longhandled tongs, maneuver linen bags, or divide up incinerator remains. For these practical reasons, the instrument is preferred for the location of lost radioactive sources and also the detection of gamma or beta contamination arising from the use of ^{131}I, ^{32}P, or ^{198}Au. (P.C.H.)

7810 DISTORTION OF THE ELECTRIC FIELD IN AN IONIZATION CHAMBER USED WITH A TOTAL-FEEDBACK ELECTROMETER. R. Loevinger (Stanford Univ., Calif.). Phys. Med. Biol., 10: 109-10(1965).

Distortion of the electric field in the specific case of a plane-parallel ionization chamber used with a total-feedback electrometer is discussed. It is commonly assumed that such an electrometer holds the collecting electrode so close to the potential of the grounded guard ring that the resulting field distortion is negligible. It is readily shown that under some, but not all, circumstances, this is the case. (P.C.H.)

7811 SUGGESTED CIRCUIT FOR A PHOTOVOLTAIC X-RAY DOSEMETER. D. Paix (Prince Henry Hospital, Little Bay, New South Wales, Australia). Phys. Med. Biol., 10: 110-11(1965).

A circuit is described that allows a photovoltaic detector to operate into a near-short-circuit and produced signals of up to 60 v. The former feature should be especially valuable at high dose rates, when such detectors lose their linear response to irradiation unless the load impedance is kept low. The latter feature means that any ordinary voltmeter can be used to indicate the output value. (P.C.H.)

7812 USE OF A PERSPEX SHEATH FOR IONIZATION CHAMBER MEASUREMENTS IN A WATER PHANTOM. M. J. Day (The Royal Victoria Infirmary, Newcastle upon Tyne, Eng.), D. Greene, and J. B. Massey. Phys. Med. Biol., 10: 111-12(1965).

Studies showed that it is convenient to use a Perspex tube round an ionization chamber used to make measurements in water because it also provides a rigid mechanical support for the chamber. The effects of the Perspex tube on the measurements made in this way were considered. Measurements showed that the effect of the Perspex cap use is very small, and that the thickness of Perspex used is not at all critical. (P.C.H.)

7813 WIDTH OF ION AND MONOPOLE TRACKS IN EMULSION. Robert Katz and J. J. Butts (Kansas State Univ., Manhattan). Phys. Rev., 137: B198-203(Jan. 11, 1965).

The width of the tracks of ions in emulsion was calculated from the assumption that an image is formed when the energy dosage deposited by delta rays exceeds a threshold value, here found to be 6000 ergs/cm^3 in G-5 emulsion. The theory agrees with measurements of track width obtained by projecting track images to a magnification of 3000× and tracing around their outline, while truncating isolated delta rays at their bases. Agreement is found within a range of a grain diameter to about 4 cm. From the theory it is inferred that there is no Z intelligence contained in the last 10 μ of track length, and that very poor resolution in Z (above 15) is obtained in the thin-down region (last 150 μ). The calculation was extended to infer the width of the track of a Dirac monopole as a function of its range. The length of track required for discrimination between ions and monopoles depends on the monopole mass. Thus monopoles of mass 5 amu, unit pole strength (137e/2), and energy 1500 Mev will have a range of 1000 μ, and can be confused in width with ions of charge 20. On the other hand 3-amu unit-strength monopoles of 100-Mev energy will have a range of 100 μ and can be clearly distinguished from any ion. If 1 cm of track is available, any monopole (to mass 50 amu) can be clearly distinguished from all ions by the fact that its track width does not diminish with increasing range, and achieves a value of about 4 μ, in G-5 emulsion. (auth)

7814 BETA-RAY MEASUREMENT BY LIGHT-PIPE C. Takei (Nagasaki Univ.). Radioisotopes (Tokyo), 13: 435-8(Nov. 1964). (In Japanese)

Since beta-ray fluorescence of anthracene crystals is strong, one can determine activity of the beta rays by leading the fluorescence through a light-pipe to a photomultiplier. Previously the author measured beta activity of the radio phosphorus deposited in a human body cavity which is accessible to an acryl light-pipe. Here the effects of the length and diameter of light-pipe on counting-efficiency and pulse-height distributions are investigated. Counting-efficiency is as large as 80 ± 5% even when the acryl light-pipe is 30 cm. Pulse-height analysis of the fluorescence which reaches photomultiplier through light-pipe shows that with increasing length and decreasing diameter of the light-pipe, the amount of higher pulses de-

creases and that of lower pulses increases. Lowering of pulse-heights of the fluorescence by transmission through light-pipe is apparently due to incomplete smoothness of the totally reflecting surface of the light-pipe used. Acryl light-pipe does not absorb light of specific wave length. As compared with acryl rod a glass fiber would be better suited for light-pipe because of the latter's flexibility and smoothness of totally reflecting surface. (auth)

7815 FUNDAMENTAL STUDIES ON THE RADIOACTIVE THICKNESS GAGE. I. ABSORPTION CURVE. Takami Koyanagi and Isao Kimura (Niigata Univ., Nagaoka, Japan). Radioisotopes (Tokyo), 13: 465-71(Nov. 1964). (In Japanese)

The absorption characteristics of radiations in the materials are the base of the radioactive thickness gage. To make the basis firm, the absorption curves of six kinds of metallic materials (Al, Fe, Ni, Cu, Sn, Pb) and six non-metallic materials (vinyl, celluloid, polyethylene and three kinds of paper) are obtained experimentally using ^{90}Sr + ^{90}Y as the β-ray source. Two kinds of detector, scintillation detector and ionization air chamber, are used. The absorption curves are affected by the experimental arrangements for thinner absorbers than a maximum range of the β-rays, especially with small field size. The absorption curves are changed by the kinds of material, namely the absorption of β-rays increases with increasing atomic number. These two phenomena can be explained by the scattering of β-rays. For the materials thicker than a maximum range, the effects of Bremsstrahlung are remarkable, when the scintillation detector is used. (auth)

7816 THE PROPAGATION OF DISCHARGES IN SELF-QUENCHING G-M TUBES. H.-G. Franke. Thesis, Münster, Ger., Universität, 1964. 33p. $2.00(Gmelin, AED-DISS. 64-100). (In German)

Results of measurements of discharge propagation times in G-M tubes indicate two possible mechanisms, the photoeffect in the gas and the photoeffect on the cathode. Both effects have nearly the same propagation velocity. A special tube with an electrical lens that influences the gas propagation was constructed. The drift velocity of photoelectrons from the cathode to the wire was measured. Results indicate, that primarily low range photons are responsible for discharge propagation. (Gmelin Inst.)

7817 PREDICTION AND MEASUREMENT OF NEUTRON CHOPPER BURST SHAPES. John Marland Carpenter. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 105p.

By applying an original method for the graphic representation of the angular and spatial density of neutrons in a collimated beam, a technique is developed for calculation of the number of neutrons passed through one or more rotating elements in such a beam. The P-gram construction is briefly discussed. The effects of moving elements in a beam of finite-velocity neutrons are described. The apparent configuration of the rotating element is shown to differ from that of a stationary element and the apparent collimator formed by it is represented in terms of the P-gram construction. Consideration of the joint probability of transmission of a neutron through both a stationary collimator, which defines a beam, and through a rotor, which interrupts the beam, leads to an expression for the time-dependent neutron transmission probability. An experiment is described in which a monochromatic neutron beam was selected by means of a crystal monochromator and the method is applied to its analysis. Formulae are presented that can be used for hand calculation of results to be expected in the experiment. Results of the measurements are displayed; these demonstrate the validity of the calculations. (Dissertation Abstr., 25: No. 2(Aug. 1964))

7818 DEVICE FOR THE MEASUREMENT OF BETA RADIATION. Eiichi Tanaka and Toshiyuki Hiramoto (to Hoshasen Igaku Sogo Kenkyusho). German Patent 1,178,524. Sept. 24, 1964. Priority date Mar. 6, 1961, Japan.

A device for the measurement of beta radiation is described. It is especially suited for the detection of very-low-energy beta rays. The device comprises a scintillation crystal, one side of which is attached to a scintillation counter. The other side of the crystal is provided with a recess in the surface, which is coated with an electrically conducting layer. The thickness of this layer is chosen in such a way that it is transparent for the beta rays to be detected. This coating is the cathode of a Geiger-Mueller counting tube, the anode of which is inserted into the recess. The scintillation counter and the G-M counter are either switched in coincidence or in anticoincidence. (Gmelin Inst.)

7819 IONIZATION CHAMBER. Jacques Engelmann (to Commissariat à l'Énergie Atomique). German Patent 1,179,306. Oct. 8, 1964. Priority date June 8, 1959, France.

A double-walled ionization chamber is described, which comprises coaxially arranged and cylindrically shaped high-voltage and collector electrodes situated within the interstice between the two walls. In order to obtain an ionization current that is nearly independent of the location of the radioactive sample within the chamber, the distance between the electrodes differed along their length. The distance between the electrodes was preferably the smallest along their middle portion. (Gmelin Inst.)

7820 SCANNING DEVICE FOR THE VISUALIZATION OF THE SPACIAL DISTRIBUTION OF RADIOACTIVE RADIATION. Julius Bosch (to Frieseke and Hoepfner GmbH). German Patent 1,179,307. Oct. 8, 1964. Filed Dec. 13, 1961.

The device comprises a proportional counter covering a large area. Through the counter volume crossed anode and cathode wires are passed. These wires are arranged in such a way that the discharges take place only in zones of the counter where the wires cross. In order to obtain the spacial distribution of the radiation several of these areal proportional counters are piled up. (Gmelin Inst.)

7821 ELECTRICAL RADIATION MONITOR. Erich Hossbach (to Graetz-Kommanditgesellschaft). German Patent 1,179,308. Oct. 8, 1964. Filed July 15, 1960.

A transistorized monitor is described which generates an alternating voltage after a predetermined radiation level is surpassed. The frequency of the alternating voltage is proportional to the intensity of the radiation. A loudspeaker is operated by this alternating voltage. For fixation of the level and generation of the alternating voltage a flip-flop connection is used, which is equipped with a semiconductor diode of quadruple layers. The transistorized amplifier is calibrated for class C operation. For control of the charging current of the flip-flop connection a transistor is provided for the emitter-collector line. It serves as a changeable charging resistor. (Gmelin Inst.)

Radiation Effects

7822 (NAA-SR-9634) LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRICAL AND ELECTRONIC COMPONENTS (BMI-LF-3). M. N. Robinson, S. G. Kimble, and D. M. Walker (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 186p. Dep.; $5.00(OTS).

Screening tests are described of nuclear radiation effects on electrical and electronic components for the SNAP 2 and 8 control systems. Five transistor models, three capacitor types, and several encapsulation materials were irradiated to 10^{16} nvt (>0.1 Mev) and 4×10^{8} R (gamma). The components were maintained at a temperature of 140°F and a vacuum of 5×10^{-4} torr. Measurements were taken of electrical characteristics during irradiation, and the resulting degradation curves were plotted by computer. (auth)

7823 (NAA-SR-9684) LOW FLUX NUCLEAR RADIATION EFFECTS ON SEMICONDUCTOR DEVICES (BMI-LF-1). M. N. Robinson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 200p. Dep.; $6.00(OTS).

The first of a series of irradiation experiments on elec-

trical and electronic devices intended for SNAP reactor control systems is described. Four types of semiconductor devices, 2N744 and 2N1072 transistors, PS760 diodes, and 1N2032 Zener diodes, were irradiated to 10^{16} nvt (>0.1 Mev) and 4.5×10^{8} R (gamma) at the Battelle Memorial Institute Research Reactor. Results are presented of in-pile measurements of the critical electrical characteristics, in the form of graphs produced automatically by a computer peripheral plotting facility. (auth)

7824 (SEG-TDR-64-7) MECHANICAL RELIABILITY AND THERMOELECTRICAL STABILITY OF NOBLE-METAL THERMOCOUPLES AT 2600°F TEMPERATURE AND DOSE RATES UP TO 10^{20} Nvt. Alfred C. Dallman (Research and Technology Div. Systems Engineering Group, Wright-Patterson AFB, Ohio). Mar. 5, 1964. 38p. (AD-601267). $1.00(OTS).

Work was carried out to obtain mechanical integrity from two-conductor platinum–rhodium sheath-type thermocouples when such thermocouples are exposed to nuclear radiation at temperature levels of 2500 to 2600°F. The final phase of this program was to prevent unstable calibration of thermocouples during in-pile tests. Predicted values of surface temperatures, calculated by careful analysis of heat-balance data (before evaluation facilities were available to recalibrate irradiated thermocouples), were determined to be several hundred degrees over measured values. After recalibration facilities became operational, the predicted values were determined to be several hundred degrees higher than measured values. Decalibration data obtained during the ICR-25 reactor test disclosed that the decalibration values ranged from –50 to –1450°F for identical, two-conductor, sheath-type MgO-insulated thermocouples that had been subjected to exposure conditions of 2600°F for 456 hours. Reactor tests during the test program demonstrated that the following were accomplished: (1) Alumina Flame spray-coating of sheath-type noble-metal thermocouples prevented excessive loss of the noble-metal sheath and sensor wire by vaporization and redeposition on cooler surfaces in reactor tests at operating temperatures of 2500 to 2600°F. (2) The use of alumina-coated, noble-metal, bare-wire thermocouple (Span thermocouple) employing a controlled, maximum, feasible separation between sensor wire and/or an alumina-coated thermocouple constructed of two one-conductor coaxial, sheathed thermoelements (Duax thermocouple) insured that temperature information, which will not be affected by significant decalibration, can be obtained for a period of 1000 hours at a test temperature of 2600°F. (auth)

7825 ELECTRON TRANSFER IN IRRADIATED VACUUM CAVITY CHAMBERS. T. E. Burlin and S. R. Husain (Dept. of Mathematics and Physics, London). Nature, 204: 563-4(Nov. 7, 1964).

Greening's proposed theory for the saturation characteristics of evacuated chambers under irradiation was investigated. A copper vacuum chamber was irradiated in the gamma field from a 2,000-C ^{60}Co unit. The experimental results were in general agreement with theoretical predictions. (M.C.G.)

7826 RESULTS OF LOW-ENERGY PROTON IRRADIATIONS OF SOLAR CELLS. E. A. Lodi, J. De Pangher, and E. B. Pearson (Lockheed Missiles and Space Co., Palo Alto, Calif.). 24p. (CONF-657-6)

From 4th Annual Photovoltaic Specialists Conference, Cleveland, June 1964.

A study was conducted to observe the damage effects produced in silicon and gallium arsenide solar cells by protons at 100 to 500 kev. The N/P cells exhibited a levelling-off in the degradation of the open-circuit voltage for large time-integrated fluxes of 130-kev protons. At 200 kev the short-circuit current displayed a double reversal in degradation. At 300 kev the degradation rate of the short-circuit current at large time-integrated fluxes was higher than it was for higher energy protons. The experiment also confirmed an earlier observation that gallium arsenide solar cells degrade rapidly when irradiated with 200- and 500- kev protons. A comparison of the low-energy proton results with previous results using 1-, 3-, and 12- Mev protons is included. (auth)

ISOTOPE TECHNOLOGY

Industrial Applications

7827 EFFECTIVENESS OF DETERGENTS DETERMINED BY MEANS OF ORGANIC MATERIALS LABELED WITH RADIOACTIVE PHOSPHORUS (P^{32}). A. Paoletti (Università, Naples). Boll. Soc. Ital. Biol. Sper., 37: 806-8(Aug. 31, 1961). (In Italian)

The effectiveness of detergents was determined by soiling fabrics and papers with ^{32}P-labeled organic materials obtained from laboratory animals inoculated with the tracer. The ^{32}P was measured before and after treatment with the detergent being tested. The results showed that the detergent action increases with the detergent concentration. Agitation and temperature increased the detergent effects. But too high a detergent concentration, too high a temperature, and prolonged agitation could lead to inexact results if the water is not carefully squeezed out. The effectiveness of a detergent was found to be dependent on the nature of the contaminated tissue or support. (J.S.R.)

7828 GAMMA-RAY EXCITED X-RAY SOURCES. J. S. Watt (Australian Atomic Energy Commission, Sydney). Intern. J. Appl. Radiation Isotopes, 15: 617-25(Oct. 1964). (AAEC/TM-226)

Gamma excited x-ray sources, yielding essentially monoenergetic x rays of energy variable in the range from a few to 100 kev, were developed. Gamma rays from a radioisotope excite a target material and fluorescent x rays with energies characteristic of the material are emitted. Only fluorescent x rays and scattered γ rays can emerge from the source assembly since the direct γ rays are eliminated by shielding. The efficiency, purity (i.e. the ratio of the number of K x rays to the number of scattered γ rays) and some practical aspects of this type of source are discussed. Since the fluorescent x rays are of well-defined, discrete energies, γ excited x-ray sources should find a wide use in applications involving x-ray fluorescence. (auth)

7829 RADIOISOTOPE WEAR MEASUREMENTS ON AXIALLY LOADED BALL BEARINGS. K. A. Detzer (Technische Hochschule, Munich). Kerntechnik, 6: 456-62(Oct. 1964). (In German)

Activation of individual bearing components in a reactor with resultant radioactivity of wear debris enabled discontinuous wear measurements to be taken separately on outer ring, inner ring, and rolling element set of axially loaded ball bearings. Gamma spectrometry of the wear debris together with microphotographs of running marks on bearing components furnished information on a possible rolling-bearing wear mechanism. (auth)

7830 ESTIMATING GAMMA-RADIATION PROCESSING COSTS. L. E. Kukacka and B. Manowitz (Brookhaven National Lab., Upton, N. Y.). Nucleonics, 23: No. 1, 74-8 (Jan. 1965).

On the basis of actual experience at operating plants, the cost of gamma processing was estimated. Information from first-generation facilities was used to develop estimates which, although undoubtedly high because the plants were designed for both production and research, do represent the only available data and should at least provide an upper cost limit. Construction contributes approximately 70% of the total plant cost, architectural fees and construction overhead constituting the remainder. Data are tabulated. The current status of radiation-processing facilities is included. (P.C.H.)

7831 APPLICATIONS OF ISOTOPES AND RADIATION SOURCES IN THE PHYSICAL SCIENCES IN JAPAN. Kenjiro Kimura (Japan Atomic Energy Research Inst., Tokyo), Fumio Yamasaki, Seizo Okamura, Masao Kato, Masatoshi Kobayashi, and Nagao Ikeda. Radioisotopes (Tokyo), 13: 491-502(Nov. 1964).

A review of the applications of isotopes and radiation sources in the physical sciences in Japan is given. Sections are presented on the use of tracers and activation techniques in physical research, use of tracers in chemical research, use of tracers in industrial processes, use of large radiation sources in industrial processes, and use of tracers in hydrology. (N.W.R.)

7832 FOOD SUPPLY AND ATOMIC ENERGY RESEARCH. Lars-Eric Ericson. TVF (Tek. Vetenskaplig Forskning), 35: 245-51(1964). (In Swedish)

The importance of atomic energy research to the world food supply is discussed. Ionizing radiation methods are analyzed, with special reference to extermination of insects and parasites, disinfection of animal products, food preservation, industrial application, plant breeding, production of vaccines, etc. (auth)

Power Application

Refer also to abstract 8661.

7833 ANALYSIS OF A RADIOISOTOPE THRUSTOR AUXILIARY POWER UNIT. D. F. Berganini, R. R. Barthelemy, and C. W. Glassburn. 17p. (CONF-446-54)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The feasibility of an isotope-powered thrustor auxiliary power unit for space uses is analyzed. The unit consists of a space thrustor radiatively coupled to a thermoelectric generator. It is concluded that a light-weight unit capable of 0.1-lb thrust at specific impulse of 750 seconds, and auxiliary power of 50 w(e) can be designed. (J.R.D.)

7834 APPLICATION OF SOLID-GAS CHROMATOGRAPHY TO THE ENRICHMENT OF LOW-LEVEL TRITIUM SAMPLES. M. B. A. Crespi and H. Perschke (International Atomic Energy Agency, Seibersdorf, Austria). Intern. J. Appl. Radiation Isotopes, 15: 569-78(Oct. 1964).

A gas chromatographic technique, which permits quantitative separation of traces of tritium from samples up to 200 ml of hydrogen (STP) using relatively small molecular sieve columns, is described. The technique applies a combination of elution and displacement chromatography and takes advantage of the variation of the retention time with temperature. The implications of the technique to low-level tritium assay are discussed. (auth)

Separation and Production

7835 AVAILABILITY OF Ca^{47} AND ENRICHED STABLE CALCIUM ISOTOPES. p.179-84 of STI/DOC/10/32.

Information is presented on organizations known to the IAEA to be suppliers of ^{47}Ca or enriched stable calcium isotopes. (H.M.G.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 7335, 7338, 7489, 7751, and 8571.

7836 (IS-940) AMES LABORATORY SDI SYSTEMS REFERENCE MANUAL. C. R. Sage, R. R. Anderson, and C. H. Cameron (Ames Lab., Ames, Iowa). Aug. 1964. Contract W-7405-eng-42. 130p. Dep.; $4.00(OTS).

A procedure to assist the machine operators, librarians, and consultants involved in the operation and upkeep of the Ames Laboratory "Selective Dissemination of Information" computer system is described. The machine operators must be familiar with the OPERATING INSTRUCTIONS for each part of the system. The librarians must be familiar with USER OPTIONS AND INSTRUCTIONS for each part of the system. The PROGRAM WRITE-UPS aid the consultant in the maintenance of the system. (auth)

7837 (NYO-1480-11) SOME EXPERIMENTS IN ALGEBRAIC MANIPULATION BY COMPUTER. Arnold Lapidus and Max Goldstein (New York Univ., New York. Courant Inst. of Mathematical Sciences). Oct. 1, 1964. Contract AT(30-1)-1480. 34p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A set of subroutines to allow algebraic manipulations on the IBM 7094 computer has been written using a List Processor, SLIP. A series of four problems of increasing difficulty were solved using these routines. These problems were: to expand and simplify a polynomial in three variables; to substitute one truncated power series into another; to obtain the series solutions of two ordinary differential equations by equating coefficients; and to obtain a partial expansion of the Fourier series solution to Laplace's equation on a rectangular region with one irregular boundary. (auth)

7838 (UCRL-7880) AN IRREGULAR TRIANGLE MESH GENERATOR. Alan M. Winslow (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 25, 1964. Contract W-7405-eng-48. 41p. Dep.; $2.00(OTS).

A code is described that constructs an irregular triangle mesh. Input to the code is prepared by dividing the mesh into regions of uniform material properties and specifying the coordinates of selected points on the boundary of each region. The code then interpolates the omitted boundary points, locates the internal mesh points of each region by the pseudo-equipotential method, and assigns regional properties to each triangle. Except that a region boundary may not cross itself, there are no restrictions on the shape of a region. The iterative procedure which relaxes the mesh uses an over-convergence factor, which is recalculated each cycle and maintained close to the optimum value in order to minimize the number of cycles needed for convergence. (auth)

7839 (UCRL-9498(Rev.)) LINEAR PROGRAM APPROACH TO LINEAR DIFFERENTIAL PROBLEMS. Jonathan D. Young (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 11, 1963. Contract W-7405-eng-48. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The numerical solution of a linear differential problem is formulated as an overdetermined linear model with the objective of minimizing approximation errors. The dual of this model is a linear program. (auth)

7840 THEOREM RELATING THE EIGENVALUE DENSITY FOR RANDOM MATRICES TO THE ZEROS OF THE CLASSICAL POLYNOMIALS. Burt V. Bronk (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 5: 1661-3 (Dec. 1964).

A theorem due to Stieltjes shows that the problem of locating the zeros of the classical polynomials is equivalent to finding the electrostatic equilibrium positions for a set of interacting point charges. Defining a density function for these same charges it is found that the density of zeros for the nth Hermite polynomial is the same as the density of eigenvalues for an ensemble of n-dimensional Hermitian matrices. Similarly the location of the zeros of the nth Laguerre polynomial determines the density of eigenvalues for an ensemble of n-dimensional positive matrices, and the zeros of the ½nth Tchebichef polynomial determine the density for the real part of the eigenvalues for an ensemble of n-dimensional unitary matrices. (auth)

7841 COMPARISON OF TWO METHODS FOR LOWER BOUNDS TO EIGENVALUES. Wolfgang Boersch-Supan (Universität, Mainz). J. Math. Phys. (N. Y.), 5: 1787-8 (Dec. 1964).

It is shown that two procedures given by Bazley and Fox for the calculation of lower bounds to eigenvalues of self-adjoint operators are essentially equivalent. (auth)

7842 S THEOREM AND CONSTRUCTION OF THE INVARIANTS OF THE SEMISIMPLE COMPACT LIE ALGEBRAS. B. Gruber (Inst. for Advanced Studies, Dublin) and L. O'Raifeartaigh. J. Math. Phys. (N. Y.), 5: 1796-1804(Dec. 1964).

An infinitesimal proof of the S theorem, which states that the invariants of a compact semisimple Lie algebra are symmetric with respect to the discrete Weyl group of the algebra, is given. The complete set of invariants of the various compact semisimple Lie algebras found by Racah are rederived in a somewhat different and explicit way, the S theorem being used to establish their completeness. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

7843 (AD-420637) A STUDY OF FERROELECTRIC MATERIALS. Final Technical Report, September 1, 1962–August 31, 1963. W. H. Taylor (Cambridge Univ., England. Cavendish Lab.). Oct. 3, 1963. Contract DA-91-591-EUC-2689. 11p. $1.60 (OTS).

This report describes a study of the high-temperature structures of $NaNbO_3$, an examination of radiation effects in ferroelectric materials, neutron scattering experiments with certain hydrogenous materials, and a study of the optical properties of some thallium halides showing dielectric anomalies. (auth)

7844 (AD-602500) STRUCTURAL FASTENING TECHNOLOGY. Progress Report No. 2, November 1963–February 1964. T. A. Roach, Jr. (Standard Pressed Steel Co., Jenkintown, Penna.), M. H. Ortner, and S. J. Klach (Vitro Labs., West Orange, N. J.). Mar. 10, 1964. Contract AF33(657)-11684. 51p. $3.00(OTS).

The static oxidation portion of the requirement study was essentially completed. Results and conclusions are reported. Manufacture and coating of Cb 752 hardware was completed. Initial tests of deformability of coated columbium alloys were begun, as was the coating comparison portion of the program. A survey of tantalum procedures was conducted and the state-of-the-art in tantalum coatings was reviewed and up-dated. Threaded fasteners of Cb 752 for mechanical property tests were completed with the exception of the threading of the nuts. (auth)

7845 (AD-608135) STUDY OF DUCTILE COATINGS FOR THE OXIDATION PROTECTION OF COLUMBIUM AND MOLYBDENUM ALLOYS. Final Report, July 1, 1963–June 30, 1964. J. J. Buchinski and E. H. Girard (Metals and Controls Inc., Attleboro, Mass.). Oct. 1964. Contract NOw-63-0706-c. 129p. $4.00(OTS).

Platinum and Pt–10% Rh were examined as potential ductile oxidation resistant coatings for FS-85 (Cb–28Ta–10W–1Zr) and TZM (Mo–0.5Ti–0.1Zr). Oxidation tests on coating materials showed that 2-mil thicknesses would provide over 100 hours of protection up to 3000°F in the absence of diffusion degradation. Roll-bonded and hermetically sealed binary composites were evaluated for oxidation and diffusion behavior. Coating lifetimes of 5 to 15 hours at 2550°F were attained before diffusion-induced failure occurred. No significant differences were observed between static and cyclic oxidation behavior. Failure mechanisms of FS-85 and TZM composites were shown to be substantially different from each other. Six materials were evaluated in screening tests for potential diffusion barriers. Only ZrO_2 showed any merit, while Re, Au, Al, BN, and Al_2O_3 did not. (auth)

7846 (AECL-2066) TRANSFERENCE NUMBERS AND THEIR RELATION TO IN-REACTOR OXIDATION OF ZIRCONIUM. S. B. Dalgaard (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1964. 20p. Dep.; $0.50 (AECL).

A corrosion test was carried out in the X-2 loop in the NRX reactor. Samples of pure zirconium and various zirconium alloys were exposed simultaneously in- and out-reactor. The pure zirconium samples exposed in-reactor exhibited a weight gain which was higher than that of the out-reactor samples by a factor of eight. The in-reactor weight gains of the alloys were higher than those of the out-reactor ones by a factor of approximately two. On the assumption that the electronic resistivity of the oxide on in-reactor samples was essentially zero, a mathematical expression was derived, expressing the value of the oxidation rate constant as a function of the ionic resistivity only. Laboratory measurements of electrical potentials across corroding oxides and calculation of ionic and electronic transference numbers indicated that the high in-reactor weight gain of pure zirconium could not be accounted for by decreased electronic resistivity of the oxide. (auth)

7847 (APED-4542) RADIATION EFFECTS ON THE MECHANICAL PROPERTIES AND MICROSTRUCTURE OF TYPE-304 STAINLESS STEEL. J. S. Armijo, J. R. Low, Jr., and U. E. Wolff (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 13, 1964. 83p.

The mechanical properties and microstructures of Type-304 stainless steel have been studied as a function of cold-work, neutron irradiation, and testing temperature. True-stress, true-strain tensile measurements have been made on specimens with various degrees of cold-work at 600 and 1300°F and at room temperature. Both nonirradiated specimens and specimens irradiated to a level of 1.25×10^{20} nvt (greater than 1 Mev) have been studied. The effects of the variables (cold-work, neutron irradiation, and test temperature) on the mechanical properties of Type-304 stainless steel are discussed, and an absorbed energy criterion is proposed as an effective method for comparing the effects of these variables. A simple method for predicting fracture angles of tensile specimens is developed from preferred orientation measurements and the distribution of the applied stress on tensile specimens. The effects of cold-work and neutron irradiation on the austenite-to-martensite transformation are reported. X-ray diffraction studies show that there is a great amount of austenite-to-martensite transformation induced by cold-work. However, no measurable austenite-to-martensite transformation results from neutron irradiation. Transmission electron microscopy is used to study the effects of neutron irradiation on the microstructure of Type-304 stainless steel. (auth)

7848 (ASD-TDR-63-753(Pt.II)) INVESTIGATION OF MECHANISMS FOR OXIDATION PROTECTION AND FAILURE OF INTERMETALLIC COATINGS FOR REFRACTORY METALS. R. W. Bartlett and P. R. Gage (Philco Corp., Newport Beach, Calif.). July 1964. Contract AF33(657)-9170. 136p. OTS.

An investigation of the oxidation behavior and related characteristics of bulk silicides and silicide coatings of molybdenum and tungsten was conducted. The study included (a) the growth kinetics of disilicide coatings, (b) marker experiments to identify diffusing species during disilicide coating formation, (c) a thermochemical analysis of halide-enhanced silicon vapor transport during coating processing, (d) the growth rates of intermediate silicides in the $MoSi_2$/Mo and WSi_2/W systems using an electron microprobe technique, (e) the microstructure of protective oxide films grown on $MoSi_2$ and the nonprotective oxidation products formed at low temperatures, (f) an analysis of the oxidation process and the resultant chemistry of the oxidation products based on thermochemical and diffusion rate data, (g) an experimental and analytical treatment of oxidation of molybdenum silicides at high temperatures, to 1600°C, and reduced oxygen pressures, and (h) a correlation of experimental coating failure times, in normal oxygen atmospheres, with the required time to transform primary disilicide coatings to lower nonprotective silicide phases. (auth)

7849 (CEA-R-2494) INFLAMMABILITE DU MAGNESIUM ET DE SES ALLIAGES DANS LE GAZ CARBONIQUE ET SES MELANGES AVEC LA VAPEUR D'EAU, L'AIR OU L'OXYGENE. (Inflammability of Magnesium and Its Alloys in Carbon Dioxide and Its Mixtures with Water Vapor, Air, or Oxygen). Pierre Baqué, Claudine Chevilliard, and Raymond Darras (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Sept. 1964. 14p. Dep.(mn).

Whereas low contents of metallic additions have only a small influence on the temperature at which magnesium

begins to burn in carbon dioxide, an increase in the specific surface area of the samples is likely to reduce it considerably, the self-heating phenomena being then more pronounced. On the other hand, the exact nature of the surrounding atmosphere is a very important factor; thus the temperature at which ignition begins increases with increasing carbon dioxide pressure, decreases very rapidly when the moisture content of this gas increases up to 3000 v.p.m., and decreases regularly when the partial pressure of air or oxygen increases. (auth)

7850 (CEND-3107-224) BURNABLE POISON ADDITIONS TO UO_2. Progress Report, July 1–September 30, 1964. R. C. Brayer and W. P. Chernock (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3107. 36p. (EURAEC-1240). Dep.(mn); $2.00(cy), 1(mn) OTS.

The problem of severe axial boron segregation produced by the migration of large (20/25 mesh) self-shielded B_4C particles through the vibrating bed during vibratory compaction of fuel rods has been resolved by a combination of incremental loading and incremental compaction. Rods have been incrementally compacted to densities of 87.3 and 88% of theoretical density and the local boron concentration along the rod was maintained within the desired range of plus or minus 20% of the mean boron concentration. Two tungsten-clad UO_2–0.05 wt % B_4C capsules have been thermally tested for a period of 100 hours each at a maximum axial temperature of 1800 and 2050 to 2200°C. An axial thermal gradient of about 16 and 21°C/cm was maintained on each capsule. These capsules will be evaluated for evidence of UO_2–B_4C reaction, boron migration, and gas release in order to verify the stability of UO_2–B_4C mixtures in a closed element. No significant axial or radial boron migration has been observed in a test element containing UO_2–0.05 wt % B_4C which was operated in an open system (slowly flowing helium gas) under combined axial and radial thermal gradients of about 4500°C/cm and about 15°C/cm with a fuel centerline temperature of 2400°C. Arrangements have been completed for the irradiation testing of two fuel rods in Saxton. Tentative plans call for the simultaneous irradiation of two full length rods in a 2 × 2 test assembly to burnups of about 2000 and 5000 Mwd/MTU at a fuel centerline temperature of 2350°C. Rods, having a geometry similar to that anticipated for use in the irradiation program (1.4 cm diameter by 84 cm long) have been vibratory compacted to 87.7% of theoretical density and the B_4C distribution was maintained within ±20% of the nominal loading. (auth)

7851 (CNLM-5942) A STUDY OF THE COMPATIBILITY OF SELECTED REFRACTORY METALS WITH VARIOUS CERAMIC INSULATION MATERIALS. D. E. Fornwalt, B. R. Gourley, and A. V. Manzione (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Nov. 30, 1964. Contract AT(30-1)-2789. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The results of optical metallographic, electron microprobe, and x-ray diffraction studies of the compatibility of columbium, tantalum, Cb–1 Zr, and tungsten–rhenium alloys in contact with both commercial grades and high purity Al_2O_3, MgO, BeO, Y_2O_3, and ThO_2 at temperatures up to 1540°C for times as long as 1000 hours are reported. Reactions were observed only in tests of Cb–1 Zr and Cb–5 Zr alloys in contact with Al_2O_3 or in contact with commercial grade ceramics containing SiO_2 as an impurity. Methods used in calculating the compositions of the reaction products from microprobe data are discussed. Tests of unalloyed columbium and Cb-5 Zr alloy with Al_2O_3 verify that the formation of the reaction products is related to the relative thermodynamic stabilities of ZrO_2, SiO_2, and Al_2O_3. Postulations concerning the mechanism of formation of the Cb_3Al, Cb_2Al, and Cb_5Si_3 observed as reaction products are presented. (auth)

7852 (EURAEC-1121) PRODUCTION OF UO_2 POWDERS FOR HIGH BULK DENSITY BY MELTING AND GRINDING AND THEIR PROCESSING INTO FUEL ELEMENTS. Quarterly Report No. 16. Special Report, July 1, 1963–June 30, 1964. W. Duerrschnabel, W. Hoppe, B. Liebmann, O. Neumann, P. Saalfeld, and L. Schikarski (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 013-63-7 TEED. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

For preparing powders of high particle density, suitable for compaction by vibration, the method of UO_2 fusion by direct current-flow under argon was further developed. A melting furnace prepares 25 to 30 kg of molten UO_2 which is then processed into powders of appropriate grain size. Another small melting furnace was built for processing enriched UO_2. It has an output of about 2 kg of molten material per charge. It is possible to prepare rods with an average density of 87% of the theoretical density by vibration; in certain instances it is possible to attain 90% of theoretical density. The density over the length of the rods depends on apparatus used for compaction and on the constancy and regularity with which the powder is fed. It was proved by ultrasonic tests that by applying the vibration process to cans of W–No. 4550 steel and Zircaloy-2, no detectable surface damage is caused. The roughing depth for steel tubes rose in the vicinity of the vibration stamper, from 1 to 2 up to 2 to 4 μ. Experiments for post-compaction of vibrated fuel rods by swaging showed that there was a linear relation between elongation and vibration density at constant cross-section reduction. Several tube end closing devices were tested for simplifying the process for swaging and finishing the elements. (auth)

7853 (EURAEC-1173) STUDY OF THE SHAPING AND IRRADIATION OF URANIUM MONOCARBIDE. Quarterly Report No. 14, April 1–June 30, 1964. J. P. Dumas and B. Mansard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Work Performed under United States–Euratom Joint Research and Development Program. Contract 080-62-3/RDF. 42p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The reticular parameter of uranium monocarbide increases under irradiation. This increase is noticeable according to the temperature at which the samples are kept at the end of irradiation. Specimens of uranium monocarbide 8% enriched with uranium-235 are produced by a solid state carbothermal treatment carried out on granules and continuous direct fusion under electron bombardment for irradiation in Melusine and Siloe. The stainless steel NS 22S-ZrC compatibility tests showed that these products could be placed in contact at temperatures reached during the irradiation provided for in EL-3. The uranium monocarbide thermal conductivity coefficient measurements gave satisfactory results up to 600°C with the apparatus intended for cell manipulation. (N.W.R.)

7854 (IS-1036) ELECTROPOLISHING THE RARE-EARTH METALS. D. T. Peterson and E. N. Hopkins (Ames Lab., Ames, Iowa). Oct. 1964. Contract W-7405-eng-82. 15p. Dep.; $1.00(OTS).

A method is described whereby the rare-earth metals can be consistently electropolished and chemically etched. The method involves cooling an alcohol-perchloric electrolyte to −76°C before electropolishing. The metals are chemically polished in the same solution. (auth)

7855 (RISÖ-90) METALLURGY SECTION ANNUAL PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31, 1964. (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Aug. 1964. 53p. Dep.(mn).

Development of a prototype fuel element for the Risö reactor project DOR is described. This fuel element is made up of nineteen fuel rods of a length of two metres, each consisting of a finned SAP tube filled with pellets of sintered uranium dioxide. The investigation of the SAP materials comprised heat treatments and destructive testing, especially creep testing at temperatures from 400 to 500°C. The influence of neutron irradiation on the mechanical properties of SAP was examined by material testing after irradiations in DR 2 up to doses of fast neutrons of 4.5×10^{20} n/cm^2 (E > 2.9 Mev). Finally the compatibility of

SAP with uranium dioxide and uranium carbide was determined at temperatures from 450 to 600°C. On the basis of all these experiments with SAP, it is concluded that SAP may be considered a satisfactory construction material for the organic-cooled reactor. Extruded SAP canning tubes furnished with cooling fins were tested destructively by burst and creep test and controlled dimensionally by non-destructive methods. These experiments showed that SAP canning tubes with acceptable tolerances and mechanical properties can be manufactured on a small scale. Satisfactory end-closures of tubes have been achieved by two different methods, flash welding and rotary-arc welding. The work on uranium dioxide included the development of a pilot process for manufacturing uranium-dioxide pellets, involving the design and construction of equipment for continuous reduction and sintering. To elucidate the properties of the SAP/uranium-dioxide fuel element during neutron irradiation, work on three rigs for DR 3, each containing ten short fuel rods, was continued. Evaluation studies were initiated comprising aluminium-base, plate-type fuel elements for specific application in the research reactors DR 2 and DR 3. The initial experiments were concerned with aluminium–nickel alloys, which have properties comparable to those of aluminium–uranium alloys. Dispersion-strengthened aluminium alloys were examined. The influence of various factors, in particular the composition of the alloys, the grain size, and the size and structure of the dispersed phase, on the strength and ductility of aluminium–aluminium oxide alloys was investigated. Methods for preparing replicas and thin film for electron microscopy were developed, and, by a combination of this technique with tensile and creep testing deformation mechanisms in aluminium–aluminium oxide alloys were examined at room temperature and at elevated temperatures. The research in powder metallurgy also comprised sintering of aluminium powder in vacuum, oxidation of aluminium powder, and development of powder-blended aluminium alloys for specific purposes. Work was moreover done on the development of reproducible methods for welding of metal-sheathed thermocouples. Among other programs can be mentioned: static corrosion of aluminium in demineralized water, the effect of inhibitors on the corrosion properties of cooling water, electroless nickel plating, and aluminium dip-brazing. The research program on uranium metal before and after irradiation was continued. Equipment modified for remote examination was installed and commissioned in the hot cells and the examination of irradiated samples and unirradiated duplicates commenced. For the examination of irradiated specimens a lead-cell line has been constructed; it comprises five cells containing material-testing equipment. (D.L.C.)

7856 (SERL-80) AN ELECTRON BOMBARDMENT APPARATUS FOR VACUUM EVAPORATION AND LIQUID METAL SURFACE-TENSION MEASUREMENTS. J. C. Kelly (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). [1959]. 7p. Dep.(mn).

An apparatus which enables even refractory metals to be vacuum evaporated easily is described. Evaporation occurs from a pendant drop and is therefore completely free from crucible contamination. A high degree of preferred orientation is present in the resolidified drop. The contour of the molten drop may be used to measure the surface tension of a metal near its melting point. The method is applied to tantalum and yields the value 2,360 dynes/cm. (auth)

7857 (WADD-TR-61-72(Vol.XXXVI)) RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME XXXVI. STUDIES OF THE QUALITY OF PETROLEUM COKE FROM A PILOT-SCALE DELAYED COKER. C. F. Stout, M. Janes, and J. A. Biehl (Union Carbide Corp. Carbon Products Div. Advanced Materials Lab., Lawrenceburg, Tenn.). Aug. 1964. Contract AF33(616)-6915. 120p. (AD-607763). $4.00(OTS).

This report describes the design, construction, and operation of an experimental delayed coking unit for the conversion of petroleum residues to coke for use as the filler component in graphite for aerospace applications. The effect of changes in operating conditions of the experimental coker, e.g., time-temperature, pressure, and recycle ratio was investigated with respect to the physical properties of graphitized extruded and molded samples. Four basic charge stocks were studied: vacuum residuum, slurry (decant) oil, thermal tar, and a low sulfur thermal tar. Variations in raw coke bulk density are reported; in addition, data concerning kerosene density, ash, and sulfur content of the 1000°C calcined cokes are also included. Changes in bulk density, weight, and volume of the extruded and molded test samples resulting from the processing steps of baking and graphitizing are reported. The CTE (coefficient of thermal expansion), specific resistance, and flexural strength of the graphitized molded plugs in both the with- and across-grain directions are reported as well as the same properties for the with-grain direction of extruded rods. High coke yields from cracked feed stocks were obtained by operating at high recycle ratios and higher-than-normal drum pressures. Thermally and catalytically cracked charge stocks were coked to produce cokes yielding fabricated graphites exhibiting low CTE. Super-heated steam introduced into the hot oil stream between the furnace and the coking drum resulted in a marked effect on the coke produced from vacuum residuum; the graphite formed using this coke as filler material was higher in CTE and more isotropic than conventional graphites, making it useful as a substrate for coatings. (auth)

7858 LOW-TEMPERATURE RECOVERY OF DEFORMED ALUMINUM. M. L. Swanson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 2063-79(Oct. 1964). (AECL-2057)

The isochronal recovery of deformed polycrystalline Al was measured from 4 to 300°K by means of residual electrical resistivity measurements. A well-defined recovery stage was observed between 60 and 100°K (stage II_A). This stage was enhanced by increasing the deformation or introducing quenched-in vacancies, and was suppressed by impurity atoms. The results can be explained by di-interstitial migration. The recovery below 60°K (stage I) amounted to approximately 5%, and was independent of impurity content or degree of deformation. Both stage I and stage II_A recovery were greatly increased by a prior deformation and low-temperature anneal. A similar increase was observed for Au. This enhancement was attributed to a change in deformation mechanism because of dislocation pinning, which resulted in the formation of a preponderance of interstitial defects. (auth)

7859 PREPARATION OF VERY FINE METALLIC MOLYBDENUM POWDER. Motichi Harda. Funtai Oyobi Funmatsuyakin, 10: 138-43(1963). (In Japanese)

Fine Mo powder for metallizing ceramic electron tubes was prepared by reducing voluminous MoO_3 in H_2 gas. A vertical-type furnace was found suitable for this purpose. A key to good results was found to be prevention of Mo lower oxide formation. The size of the H_2-reduced Mo was 0.55 μ. (JRD)

7860 EPITAXIAL GROWTH ON MgO OF NIOBIUM FILMS INVESTIGATED BY ELECTRON MICROSCOPY. T. E. Hutchinson (Minnesota Mining and Mfg. Co., St. Paul). J. Appl. Phys., 36: 270-3(Jan. 1965).

Niobium films deposited in vacuum ($< 5 \times 10^{-6}$ torr) on a (100) face of cleaved MgO were found by electron microscopy to have two types of epitaxial growth, independent of the deposition rate (2 to 120 Å/min). Although the epitaxial films have a very high dislocation density for substrate temperatures below about 500°C, thin films (< 250 Å) grown between 500 and 600°C have no crystalline defects observable either by direct electron microscopy or in overlapping Moiré fringe patterns. Perfect (001) epitaxy with $[100]_{Nb}$/$[100]_{MgO}$ occurred in these thin films for substrate temperatures from 25 to 600°C. Thicker films (>400 Å), have regions of a new orientation which enlarge as the films thicken, until only the new orientation is observed at 1000 Å and thicker. These nuclei are oriented with a {110} plane parallel to the substrate surface and a ⟨110⟩ direction along a ⟨100⟩ direction in the substrate. These nuclei grow more rapidly along their ⟨110⟩ directions. Nucleation of the new

structure is discussed briefly. Calculation of the lattice misfits shows that neither of the observed orientations minimizes misfit. (auth)

7861 MOLYBDENUM FOR NUCLEAR ENERGY APPLICATIONS. A PERSPECTIVE. New York, Climax Molybdenum Company, [1964]. 112p.

The role of Mo in development of civilian nuclear power is examined. The discussions are presented in sections on properties and prospects of Mo for the nuclear energy age and representative uses of Mo in nuclear energy applications. Information on world power reactors is included along with a description of power reactor operation and a directory of alloy trade names. (J.R.D.)

Corrosion

Refer also to abstracts 7262, 7676, and 8634.

7862 (APED-4413) ZIRCALOY-2 AND TYPE-304 STAINLESS STEEL AT 2000°F IN WATER–STEAM FOR BRIEF TIMES. R. H. Leyse (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 27, 1964. 18p.

Zircaloy-2 and Type-304 stainless steel tubes (0.560 inch OD, 0.500 inch ID) were film-boiled at 2000°F in a water–steam environment for various times up to 1 hour. In addition, one UO_2 fuel rod with Zircaloy-2 cladding was film-boiled at about 2000°F and 800 psi for about 1 minute. The results show that rupture of the cladding is not expected to develop during short-term overheating. However, grain growth within the cladding, surface corrosion, and cladding-UO_2 reactions at 2000°F could possibly shorten the long-term life of the fuel. (D.L.C.)

7863 (BNL-7642) METALLOGRAPHY OF REFRACTORY METALS SUBJECTED TO LIQUID METAL CORROSION. J. Sadofsky, O. F. Kammerer, and J. Halford (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Several metallographic techniques are described which were used with Nb–1% Zr and Nb. A H_2O–HNO_3–H_2SO_4–HF etchant was used to eliminate cold work effects caused by grinding and polishing. The cracking of a Nb–1% Zr loop containing boiling mercury is described. A stain etching technique was used to identify carbides, nitrides, and oxides in Nb–1% Zr and Nb. (D.L.C.)

7864 (EURAEC-1225(Pt.1)) A STUDY OF SOME METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO THE STUDY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Quarterly Report No. 10, July 1–September 30, 1964. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Work on oxide germination and growth in metals and alloys is described. The induction period of Cu iodination is discussed. Electron microscopic observations are given of discontinuous oxide films on Al and of selective oxidation of Cu–0.01% Ni alloy. (D.L.C.)

7865 (EURAEC-1237) STUDIES ON THE CORROSION OF STEELS IN HIGH-TEMPERATURE WATER AND STEAM. Quarterly Report No. 9, July 1 to September 30, 1964. (Société d'Études, de Recherches et d'Applications pour l'Industrie, Brussels). Oct. 30, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 089-62-7 RDB. 48p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The static corrosion tests on stainless steel AISI 304 in high-temperature water and steam were completed. Mechanical treatment of surfaces is unfavorable in water at temperatures below or equal to 300°C. It has little effect in superheated steam below 400°C; on the other hand, it becomes advantageous from 400°C onwards and the more so the higher the temperature. For the states which have not been surface work-hardened, a regular increase in the corrosion is noted in terms of the temperature, as long as the corrosion values obtained in water at a relatively low temperature (200°C in particular) are not taken into account. These are increased by the "metal in water" component. It is supposed that this effect is attributable to the formation of ferrous hydroxide which, at these temperatures, is relatively soluble. The corrosion values obtained in water and superheated steam, differing notably below 300°C, meet at that temperature. The corrosion increase in terms of the temperature is particularly pronounced from 400°C onwards. For the surface work-hardened states, corrosion evolution in terms of the temperature is much more complex. In water at temperatures below or equal to 300°C, the relatively high degree of corrosion for work-hardened states does not evolve with the temperature. This fact must be associated with the amount of the "metal in water" component at 250°C and still more so at 200°C. Above 300°C, the corrosion in water of work-hardened states decreases and shows a tendency to meet up with the curve obtained for corrosion in superheated steam. In the latter medium, a slight, irregular increase in corrosion is noted between 250 and 500°C. Above 500°C the corrosion decreases and the oxide film adheres perfectly firmly. X-ray diffraction analyses confirmed the nature of the internal layer formed on the non-work-hardened states at 500°C; it consists of a mixed zone with spinel oxides and a residual austenite with a composition different from that of the original alloy. Two dynamic corrosion tests lasting 6 weeks, in water at 300°C, 150 kg/cm^2, 10 m/sec, were repeated for stainless steel AISI 304 and carried out for Creusot 1.2 MDO 7 boilerplate steel. The parameter studied in both cases is the surface state. The reproducibility of the successive tests is satisfactory. In the case of 18-10 stainless steel, the results obtained demonstrate the importance of the roughness factor in the fixation on the autoclave walls of corrosion products suspended in the water. On the other hand, it appears that in the absence of corrosion products in the water, the surface state factor can have no appreciable influence at a rate of 10 m/sec. For the boilerplate steel, the principal conclusion of the tests concerns the importance of the "metal in water" component which attains 93% of the total corrosion irrespective of the surface state. The surface states classification remains the same as that given at the time of the previous static tests; the differences between the surface states are however greatly attenuated at 10 m/sec. (auth)

7866 (GEAP-4437) SODIUM MASS TRANSFER—X. 1963 CORROSION SAMPLE DATA. L. E. Pohl, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Feb. 1964. Contract AT(04-3)-189. 187p. Dep.(mn); $5.00(cy), 3(mn) OTS.

A collection of analysis reports is presented for all the test runs completed in 1963 for each of the six loops. Each analysis report gives loop operating conditions, corrosion data, and metallographic examination results for the specimens. The specimen materials investigated include 316 stainless steel, 2¼ Cr–1 Mo steel, 5 Cr–½ Mo–½ Ti steel, and 5 Cr–½ Mo–¼ Ti steel. (D.L.C.)

7867 (GEAP-4504) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Summary Report. H. H. Klepfer (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). May 19, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 94p. (EURAEC-1193). Dep.(mn); $3.00(cy); 2(mn) OTS.

The results of selected basic experiments gave strong indications that the corrosion and corrosion hydriding of zirconium alloys is dependent on the chemical, mechanical, and electrical properties of the oxide film. The composition of corrosion films was found to be directly proportional to the alloy content of the substrate even in complex alloys. Excellent agreement was found between the activation energy for oxygen diffusion in $ZrO_{1.994}$ and the activation energies for parabolic or cubic oxidation of zirconium in both air and water. Iron, chromium, and nickel had no significant effect on oxygen ion diffusion, but the addition of 1 mole % Y_2O_3 to monoclinic zirconia increased the rate of oxygen diffusion by about 1 order of magnitude. Yttrium

decreased the plasticity of zirconium oxide while chromium and iron increased plasticity, and thus accounted for the early spalling of oxide observed for Zr–Y alloys and the good adherence of films on Zr–Cr and Zr–Fe alloys. Corrosion hydriding of zirconium alloys could not be directly related to the electro-chemical properties of the matrix and the intermetallic phases in an alloy. Corrosion hydriding may be controlled by whether electronic, or protonic, charge transport is promoted by the addition of a given alloying element to the zirconium oxide film. Corrosion rates, hydriding rates, and mechanical properties of 31 alloys containing selected additions of Nb, Cr, Fe, or Cu were measured at 300, 400, and 500°C. Selection of the 31 experimental compositions from the predetermined range of additions was treated as a statistical problem. A near-orthogonal design ensured computer analysis of the results to give polynomial expressions of the alloy response surfaces. None of the better alloys will be applicable as fuel cladding for superheat reactors. The experimental results were analyzed for the best alloy for service as water reactor fuel cladding and the optimum alloy was computed to be one containing 2.0 at. % Cr + 0.16 at. % Fe. Special experiments showed that neither Ni nor Be additions to Zr + 2.0 at. % Cr gave better overall performance than did the Fe addition. An increase in performance did result from increasing the final annealing temperature for corrosion samples to 788°C from the reference temperature of 565°C. The Zr–Cr–Fe alloy has about the same fabricability and tensile properties as does Zircaloy-2; it is superior to Zircaloy-2, particularly in resisting the adverse effect of over-temperature on the rates of corrosion and corrosion hydriding. The alloy has been recommended for evaluation as fuel element cladding. (auth)

7868 CORROSION. VOLUME 1. CORROSION OF METALS AND ALLOYS. L. L. Shreir, ed. New York, John Wiley and Sons, Inc., 1963. 932p.

Bibliographies and discussions are included on the corrosion and oxidation of ferrous metals andalloys, nonferrous metals and alloys, rare metals, and noble metals. The influence of environment, temperature, and mechanical factors in oxidation and corrosion is also considered, with special attention given to corrosion in water-tube boilers. (M.C.G.)

7869 CORROSION. VOLUME 2. CORROSION CONTROL. L. L. Shreir, ed. New York, John Wiley and Sons, Inc., 1963. 875p.

Methods adopted to limit corrosion to a desired degree, according to the economic requirements of given situations, are discussed. Topics covered include: design for the limitation of corrosion, cathodic protection, pretreatment and design for metal finishing, methods of applying metallic coatings, protection by metallic coatings, paint coatings, chemical conversion coatings, miscellaneous coatings, conditioning the environment, non-metallic materials, and corrosion testing. A glossary of corrosion terms and a collection of data tables on corrosion are also given. (M.C.G.)

7870 THE PROBLEMS OF AQUEOUS CORROSION IN THE FIELD OF NUCLEAR ENERGY. H. Coriou (CEN, Saclay, France). 42p. (CONF-757-1). (In French)

From International Energy Exhibition, Paris, May 1964.

The corrosion behavior in water or water vapor at high and low temperatures and under irradiation is described for Al and its alloys, Mg and its alloys, Zr, Zircaloy-2 stainless steels, alloys with a Ni base, and U and its alloys. (J.S.R.)

Fabrication

7871 (AD-422001) REFRACTORY ALLOY FOIL ROLLING DEVELOPMENT PROGRAM. Phase IV Interim Report, June 1–September 1, 1963. (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33 (657)-8912. 13p. $2.60(OTS).

Rolling of 12-in. wide refractory alloy sheets from 0.1-in. thickness to 0.015-in. is described. The five alloys are D-43 (Cb–10% W–1% Zr–0.1% C), B-66 (Cb–5% Mo–5% V–1% Zr), Cb-752 (Cb–10% W–2.5% Zr), Ta–10% W, and T-111 (Ta–8% W–2% Hf). Mechanical property and analytical data are included. (auth)

7872 (AD-426539) DISTILLATION OF BERYLLIUM BY SUBLIMATION AND EVAPORATION. Interim Report, August 15–November 30, 1963. G. London and M. Herman (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract AF33(657)-11233. 13p. (I-B2122-1)

Equipment and techniques for preparing high-purity beryllium by volatilizing it without the use of a containing crucible and under high-vacuum conditions are being developed. Initial efforts toward developing a system suitable for distillation studies consisted of evaluating the conditions for melting the end of a one-inch-diameter bar held vertically in a sealed quartz chamber. This was changed to the technique of using a water-cooled copper pedestal to support and stabilize a slug of molten beryllium. The water-cooled copper pedestal melting equipment is now being used for the collection and analysis of vacuum-deposited beryllium under a variety of operating conditions. (N.W.R.)

7873 (APED-4612) A STUDY OF A WELDED TUBE-TO-TUBE SHEET JOINT DESIGN. B. D. Hackney, P. J. Herbert, and C. J. McDaniel (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1, 1964. 47p.

A detailed study of a welded tube-to-tube sheet joint design for heat exchangers and similar applications has been conducted. In this weld joint design, the tube is recessed slightly below the external surface of the tube sheet. The welding arc is directed exclusively upon the tube sheet and welding proceeds around the periphery of the joint by means of the gas tungsten arc welding process. No filler metal or special preparation of tube sheet is required. A series of welds were made in which the variables were: Tube Materials: 304 and 304L stainless steel, Monel-400, Inconel-600, and 70-30 and 90-10 copper–nickel. Depth of Tube Below Tube Sheet Surface: $\frac{1}{4}t$ through $1\frac{1}{2}t$ in $\frac{1}{4}t$ increments, where t is equal to the nominal tube wall thickness. Tube Wall Thickness: 20 through 60 mil wall. Composition of Welding Shield Gas: Argon, 95% argon–5% hydrogen, and helium. Welding Position: tube sheet horizontal and vertical. Weld specimens containing all of the above variables were subjected to a program of mechanical testing and metallographic examination. It has been demonstrated that this joint design will function exceptionally well under a variety of material, geometrical, and welding conditions. It consistently provides a leak path greater than $\frac{3}{4}t$ and mechanical strength nearly equal to the ultimate strength of the tubing material. This welded tube-to-tube sheet joint design will provide a high incidence of weld quality with a minimum of welder skill and joint preparation. It is recommended that APED include this design as preferred for heat exchangers and similar applications used in APED-designed reactor plants. (auth)

7874 (ASD-TDR-7-911(V)) IMPROVED PRODUCTION OF POWER METALLURGY ITEMS. Interim Technical Documentary Progress Report, July 1–September 30, 1963. K. Farrell, S. A. Spachner, and N. M. Parikh (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AF33 (657)-9140. 16p. (AD-421065). $2.60(OTS).

The synthesizing results on TZM alloy are summarized, and it is shown that it is difficult to obtain the precise carbon content. The atomizing technique has been modified so that superalloy powders of low gas content can now be made on a commercial scale. The results of extrusion experiments in which T-sections are made from Ph 15–7 Mo alloy, TZM alloy, and a sintered powder billet of Udimet 700 alloy are described and discussed. (auth)

7875 (HW-80505) COMPARISON OF URANIUM AND ZIRCONIUM EXTRUSION PERFORMANCE WITH CRITICAL ANGLE ULTRASONIC TESTS. G. L. Waldkoetter (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 7, 1964. Contract AT(45-1)-1350. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The ultrasonic technique used to test the ID of the ura-

nium billet responds to the elastic properties of the metal to an approximate depth of 0.021 inches. The method used indicates changes in both structure orientation and grain size. The Zircaloy test makes use of boundary wave phenomena to indicate changes in the Zircaloy structure. Forging memory effects can be detected in the Zircaloy which have been shown to add to inner clad variation of the coextruded N fuel. The results show that there is an influence of both uranium and Zircaloy structure upon the inner-clad variation of the coextruded outer tube fuel. Analysis of the combined uranium and Zircaloy test data has demonstrated a potential pre-characterization of the extrusion assembly. (auth)

7876 (ML-TDR-64-71) DIFFUSION COATING PROCESS FOR COLUMBIUM-BASE ALLOYS. William L. Aves, Jr., Gordon W. Bourland, Aleck B. Featherston, Brennan A. Forcht, and Kent P. O'Kelly (Vought Astronautics. Div. of Chance Vought Aircraft, Inc., Dallas). Nov. 1962. Contract AF33(616)-7896. 166p. (AD-603002). $5.00(OTS).

A study was conducted to improve and optimize coatings for Nb alloys, protective in air to 2600°F for at least 10 hours. Process variables of two different silicide base coating systems (Si–Cr–Al and Si–Cr–B) applied by a two-step pack cementation process were optimized by statistical methods. Coatings were evaluated on D-31, C-103, Nb–1Zr (FS-80), and FS-82 niobium alloys. Oxidation resistance testing included furnace testing in moving air, sustained load thermal cycling, propane torch and ram-jet tests. Tensile strength and bend properties of uncoated and coated alloys were evaluated at room and elevated temperatures. An analytical evaluation of these systems was conducted to characterize the coating components. In addition, oxidation tests in the range 1000 to 2000°F were conducted to determine "di-silicide pest" effects on the two systems. The Si–Cr–B system was unaffected by this phenomenon. (auth)

7877 (ML-TDR-64-74) DEVELOPMENT OF A POWDER AND/OR GAS CEMENTATION PROCESS FOR COATING MOLYBDENUM ALLOYS FOR HIGH-TEMPERATURE PROTECTION. Herman Blumenthal and Neil Rothman (Chromalloy Corp., West Nyack, N. Y.). Mar. 1964. Contract AF33(616)-7383. 114p. (AD-603021). $4.00(OTS).

As-prepared W-2 coating on Mo–0.5 Ti was found to be essentially $MoSi_2$. Upon exposure at 2700°F, the coating becomes three phase and develops an oxidation-resistant glaze. A statistically designed experiment was run on two levels of each of nine process variables in order to optimize the W-2 coating process. This experiment indicated that the three most important process variables were time and temperature of processing and mixing of the coating powders. Soundness of the Mo–0.5 Ti surface and acid etching of the surface were of secondary importance. Purity, particle size, and age of powder mixture and retort material were, statistically, minor in importance. The recommended optimum coating would be produced by processing uncontaminated surface Mo–0.5 Ti etched and honed. The work piece should be immersed in a commercial purity, –60 plus 150 mesh powder that is well mixed. The work should be processed twice (12 hours at temperature each time) at 1900°F in a steel retort. The coating produced should have a wear life of 47 hours and a standard deviation of 8 hours at 2700°F under the oxidation conditions used in this program. (auth)

7878 (RTD-TR-8-112(I)) EXTRUDING AND DRAWING MOLYBDENUM TO COMPLEX THIN H-SECTION. First Interim Technical Engineering Report, July 1–September 30, 1963. P. A. Santoli (Allegheny Ludlum Steel Corp. Research Center, Brackenridge, Penna.). Oct. 1963. Contract AF33(657)-11203. 14p. (AD-421882). $1.60 (OTS).

Tooling in process will be for the evaluation of various die materials by the extrusion of TZM solid rounds. Zirconia as flame-sprayed deposits and pressed and sintered solid nibs have been given primary consideration as the most promising die material. H-shaped dies then will be prepared on the basis of results obtained. The extrusion of 24 TZM solid rounds has been planned for the initial program activity. Support tooling such as a stem, liner and back-up block are in process and near completion. (auth)

7879 FILM DEPOSITION USING ACCELERATED IONS. D. M. Mattox (Sandia Corp., Albuquerque, N. Mex.). Electrochem. Technol., 2: 295-8(Sept.-Oct. 1964). (TID-18639)

The ion-plating technique has proven to be valuable in the deposition of normally poorly adherent couples and provides another deposition technique which can be used in an inert gaseous environment. The question of why there is enhanced adherence between nonsoluble materials using this process is a difficult one to answer and awaits a better understanding of the role structure has on surface properties. (auth)

7880 A STATISTICAL ANALYSIS APPLIED TO ARC MELTING TUNGSTEN-BASE ALLOYS. J. L. Ratliff and H. R. Ogden (Battelle Memorial Inst., Columbus, Ohio). J. Metals, 16: 950(Dec. 1964).

Data were obtained from a review of current arc-melting practices presently applied at seven different arc-melting facilities to establish a relationship between the melting variables for tungsten. Generally, the review was limited to d-c, straight-polarity melting methods. A moderately broad range of values was obtained for each variable considered important to process. The data were analyzed by a semiempirical method to establish the relationship between the arc-melting variables. Using an optimum adjusted melting-rate parameter, the five basic arc-melting variables were related according to the formula: $P = 10R\rho\,(0.8D_e^2 + 0.2D_i^2) + 100$, where P is input power, R is melting rate, ρ is electrode density, D_e is the diameter of the electrode, and D_i is the diameter of the ingot. (P.C.H.)

7881 STUDY OF THE SINTERING MECHANISMS FOR POWDERED URANIUM IN α, β, γ PHASES. B. Pinteau, G. Cizeron, and P. Lacombe (Ecole des Mines, Paris). Mem. Sci. Rev. Met., 61: 787-804(Nov. 1964). (In French)

Dilatometric studies were made of the mechanisms of sintering powdered uranium in α, β, and γ phases. The influence of allotropic transformations on the kinetics of shrinking was determined. The microstructure and certain physical properties of sintered uranium were studied in three phases. Measurements were made of density and porosity. Interpretations of the observed phenomena are included. (auth)

7882 FUSION OF ZIRCONIA POWDER BY ARC PLASMA FLAME. Osamu Yonemochi, Tsutomu Okubo, Minoru Maeda, Hiroshi Hayashi, and Choji Noguchi. Nagoya Kogyo Gijutsu Shikensho Hohoku., 13: 31-8(Jan. 1964). (In Japanese)

Zirconia powder was fused in a plasma arc operated at 300 to 650 amp using gas flows of 17.5 to 51/min. The fused particles were spherical and hollow. The particle size became larger with increased current. Satisfactory fusion requires high-fluidity raw powder. The method was considered inferior to furnace fusion. (J.R.D.)

7883 WELDING OF GRAPHITE. G. Blet. Rev. Met. (Paris), 61: 909-10(Oct. 1964). (In French)

Improving the mechanical strength, electric conductivity, thermal conductivity, and high-temperature properties of bonds in graphite by adding a filler metal such as titanium is described. X-ray-diffraction studies were made of the structure of welds produced in this way. Face-centered-cubic TiC was found to be present in the highest temperature zone. (auth)

7884 PRODUCTION OF TUNGSTEN SHEET BARS BY ZONE REFINING OF CEMENTED TUNGSTEN ALLOYS. N. M. Parikh (Illinois Inst. of Tech., Chicago) and S. V. Arnold. 20p. (CONF-603-6)

From Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June-July 1964.

It was demonstrated that it is feasible to prepare blanks of cemented tungsten alloy, 96W-4(7Ni:3Fe) by sintering at 2800°F, which can be warm rolled to suitable sheet bar dimensions using conventional rolling mills and furnace

equipment. The cemented alloy sheet bar can be zone refined to remove nickel and iron and comply with the specified purity of commercial tungsten. Sheets rolled from this bar possess ambient and elevated temperature properties equivalent to those of the commercial product. Advantages of the method are listed. (P.C.H.)

7885 VACUUM ARC MELTING OF Mo–TZC ALLOY. S. Inouye (Air Force Materials, Lab., Wright-Patterson AFB, Ohio). 26p. (CONF-603-7)

From Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June-July 1964.

Effective methods to prevent or minimize gross ingot defects in vacuum arc melted Mo–TZC (Mo-1.25% Ti-0.3% Zr-0.15%C) were investigated. Ingot defects were of two general types: cracks and porosity. Four methods were investigated to improve ingot soundness: adjustments in melting current and voltage; modified hot-topping procedures; Mo additions on the ingot top surface; and reduced heat flow at the ingot bottom surface. Each of the methods was chosen to improve conditions for freezing and cooling at different ingot locations. Extended periods of hot-topping were effective in reducing the depth of cracking at the top of the ingot. The addition of Mo to the ingot top surface as part of the consumable melting process was an effective means to eliminate cracks from the ingot top surface and required no prolonged hot-topping procedure. (P.C.H.)

7886 FORGEABLE MAGNESIUM–ZIRCONIUM ALLOY AND METHOD OF PRODUCTION. Edward Frederick Emley (to Magnesium Elektron Ltd.). German Patent 1,174,081. July 16, 1964. Priority date Oct. 18, 1960, Great Britain.

The alloy is composed of 0.1 to 1% zirconium, at least 0.002% hydrogen, 0 to 0.3% manganese, 0 to 3% rare earth metals, 0 to 3% thorium, 0 to 0.01% beryllium, and the rest magnesium. The method comprises the steps of treating a casting or a pressed piece of the alloy in hydrogen at 300°C for ½ an hour, so that 0.002% hydrogen is absorbed, and then plastically deforming the alloy. (Gmelin Inst.)

Properties and Structure

Refer also to abstract 7674.

7887 (AD-421621) THE USE OF STRAIN SOFTENING TO IMPROVE THE PROPERTIES OF REFRACTORY METALS. Quarterly Progress Report No. 5, June 1, 1963–August 31, 1963. S. Mostovoy and E. J. Ripling (Materials Research Lab., Inc., Richton Park, Ill.). Contract NOw62-0725-C. 15p. $1.60(OTS).

The molybdenum–0.5 Ti Alloy was flexed at room temperature with the largest available rolls during this time period. It was found that two passes lowered the transition temperature by 60°F. Measurement of these strains by use of photogrid techniques and by measuring the radius of curvature of the bent plate indicates that the large rolls are producing almost twice as much surface strain as the medium-sized ones. Flexing TZM alloy produced results that were quite different from those attained on the molybdenum–0.5 Ti Alloy. In the latter, the NDT temperature was suppressed with only modest changes in the "knee" of the ductility-testing temperature curve. In the TZM, on the other hand, the NDT was essentially unchanged by flexing, while the knee was lowered approximately 100°F. In the first attempt to flex tungsten, there was no property improvement. (auth)

7888 (AD-607799) EFFECT OF ELECTRON CONCENTRATION ON THE PROPERTIES OF ALLOYS OF REFRACTORY METALS. Annual Topical Report. J. G. Booth (Battelle Memorial Inst., Columbus, Ohio). Oct. 30, 1964. Contract Nonr-3589-(00). 30p. $2.00(OTS).

The Re effect (improvement of Mo and W ductility by alloying with Re) is discussed. Magnetic susceptibility measurements were made for Group VIA metals and alloys, particularly alloys of Re with Cr and W. The results indicate that the addition of Re to Cr, Mo, and W results in an increase of the Fermi state density, and that this effect is not so great for the 4d and 5d metals. Interstitial solubilities in bcc transition metal alloys are discussed. Observations on the antiferromagnetic behavior of alloys of Cr with Re, Ru, Rh, and Os are given and discussed. (D.L.C.)

7889 (ATL-A-143) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Progress Report No. 10, April–June 1964. K. E. Horton and J. M. Hallander (American Radiator and Standard Sanitary Corp. Advanced Technology Labs. Div., Mountain View, Calif.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 25p. (EURAEC-1135). Dep.(mn); $1.00(cy), 1(mn) OTS.

Testing of A302B ferritic pressure-vessel steel is complete, and testing of Types 403 martensitic stainless steel and A387D chromium–molybdenum (Croloy $2\frac{1}{4}$) steel is 50% completed. Most of the tests conducted during this quarter were on A387D steel. Emphasis was placed, however, on vacuum tests of A302B steel in an effort to eliminate oxidation effects. Reverse thermal-stress-fatigue testing on 403 stainless steel was also emphasized in an effort to prevent the low-cycle buckling phenomenon. A cursory electron-microscopic examination of tested specimens was made. The substructures of small- and large-grained materials were observed in order to ascertain why there was no grain-size effect on the thermal-stress fatigue behavior of 304-L steel. (auth)

7890 (BDX-613-7) CONDUCTIVE ADHESIVES—A SUBSTITUTE FOR SOLDER. R. L. Martin (Bendix Corp., Kansas City, Mo.). Aug. 1960. Contract AT(29-1)-613. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A number of conductive adhesives (type: epoxy resin base loaded with conductive metal) were evaluated for use as a substitute for lead–tin solder in joining electronic components. Test blocks of Cu and steel were used, and resistance and tensile strength measurements were compared with those of soldered blocks. The practical application of the results is discussed. (D.L.C.)

7891 (BMI-1696) THE MIGRATION OF GASEOUS AND SOLID FISSION PRODUCTS IN IRON–20 w/o CHROMIUM AND IRON–29 w/o NICKEL–13 w/o CHROMIUM. Arthur A. Bauer, ed. (Battelle Memorial Inst., Columbus, Ohio). Oct. 20, 1964. Work Performed under United States–Euratom Joint Research and Development Program. 41p. (EURAEC-1267). Dep.(mn); $2.00(cy), 1(mn) OTS.

The behavior of fission gases in iron–20 wt. % chromium alloy was studied by measuring release of ^{133}Xe from recoil-impregnated surfaces, by concentration-gradient measurements, through in-pile release measurements, and by electron microscopic techniques, The mechanism suggested to explain all of the results requires the clustering or trapping of the fission gases within the alloy. Solid-fission-product diffusion measurements were performed from 600 to 1200°C on iron–20 wt. % chromium and iron–29 wt. % nickel–13 wt. % chromium alloys. Two types of diffusion processes were observed. In the body-centered-cubic iron–20 wt. % chromium alloy, tellurium, ruthenium, and molybdenum diffused with frequency factors (D_0) and activation energies (Q) which fell in the range predicted for a normal vacancy process, being similar to those for self-diffusion. Cerium, barium, iodine, and zirconium/niobium gave considerably lower values of D_0 and Q in the iron–20 wt. % chromium alloy, while in the face-centered-cubic iron–29 wt. % nickel–13 wt. % chromium alloy all elements exhibited the second type of behavior with low values for D_0 and Q. (auth)

7892 (CONF-640702-2) THE STRUCTURES OF YTTRIUM–ZINC INTERMETALLIC COMPOUNDS. K. S. Sree Harsha and Earle Ryba (Pennsylvania State Univ., University Park). [1964]. Contract [AT(30-1)-2133]. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

From American Crystallographic Assoc. Annual Meeting, Bozeman, Mont.

The structures of the compounds YZn_2, YZn_3, and YZn_4, and of a new compound Y_3Zn_{11} were determined. Space

groups, lattice parameters, and atom positions are tabulated for each compound. (D.L.C.)

7893 (DMIC-207) CURRENT METHODS OF FRACTURE-TOUGHNESS TESTING OF HIGH-STRENGTH ALLOYS WITH EMPHASIS ON PLANE STRAIN. J. E. Campbell (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 31, 1964. Contract AF33(615)-1121. 23p.

Fracture-toughness testing using principles of fracture mechanics has developed to the point where it can be used as a basis for selection of materials, for estimating limiting design stresses assuming the presence of small flaws, and for analyzing failures. Current methods of measuring plane-stress and plane-strain fracture-toughness parameters are presented in this report. The specimens include center-cracked, edge-cracked, single-edge-cracked, surface-cracked, and notched round bars, which are subjected to tensile loading, and notched bars for bend tests. The different types of specimens permit evaluating sheet, plate, bar stock, and forgings as well as material from failed structures. Application of fracture-toughness parameters to design of high-strength structures is reviewed for both static and fatigue loading. Consideration of the fracture-mechanics concepts in design should lead to fewer problems with brittle fracture in high-strength structures. (auth)

7894 (DRI-2197) PHASE EQUILIBRIA OF THE TANTALUM-RICH REGION OF THE TANTALUM–TUNGSTEN–HAFNIUM AND TANTALUM–TUNGSTEN–ZIRCONIUM SYSTEMS. Quarterly Progress Report No. 1. Donald T. Klodt and Albert S. Yamamoto (Denver. Univ. Denver Research Inst.). Dec. 1964. Contract AT(11-1)-1092. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The phase equilibria at three isothermal levels are being investigated in the tantalum-rich region of the Ta–W–Hf and Ta–W–Zr alloy systems. Alloys are prepared by arc melting charges consisting of a 60 wt. % Ta–40 wt. % W master alloy with additions of tantalum and hafnium or tantalum and zirconium. Isothermal anneals at 1600°C, 1300°C, and 1100°C will be conducted, and the phase equilibria established in these alloys at these temperatures will be determined through metallographic and x-ray-diffraction studies. The preparation of the master alloy and the arc melting of alloys for the research program are discussed. (auth)

7895 (DRI-2198) STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. Albert S. Yamamoto (Denver. Univ. Denver Research Inst.). Dec. 1964. Contract AT(11-1)-1092. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Investigation of the effect of carbon and oxygen additions on the phase relationships of the niobium-rich region of the niobium–tungsten–hafnium and niobium–tungsten–zirconium alloy systems is underway. A Nb–5.18 wt. % C (analyzed) master alloy was prepared for carbon addition in these refractory metal alloys. A first series of Nb–W–Hf–C alloys at nominal 0.5, 0.25, and 0.1 wt. % C was melted and is now being readied for homogenization heat treatment. After homogenizing these alloys will be equilibrated at 1600 and 1300°C. (auth)

7896 (CEA-2444) ÉTUDES D'ALLIAGES PLUTONIUM–FER ET D'ALLIAGES URANIUM–PLUTONIUM–FER. (Studies of Plutonium–Iron and Uranium–Plutonium–Iron Alloys). Ehud Avivi (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1964. 72p. Dep.(mn).

Thesis submitted to Université, Paris.

The plutonium–iron system was studied by means of dilatometry, x rays, and metallography, especially in the domain between $PuFe_2$ and Fe. The solubilities of Fe in $PuFe_2$ and of Pu in Fe were determined. The presence of a hexagonal $PuFe_2$ phase is shown, and a modification in the Pu–Fe phase diagram is proposed. Some low iron concentration U–Pu–Fe alloys were also investigated. It was confirmed that adding some iron lowers the quantity of the zeta U–Pu phase. Some characteristics of the alloys having the global concentration $(U,Pu)_6Fe$ are shown. (auth)

7897 (CEA-R-2445) INFLUENCE DES IMPURETES SUR LA FRAGILITE A CHAUD DU BERYLLIUM DE PURETE COMMERCIALE. (Effect of Impurities on the High-Temperature Brittleness of Commercial-Grade Beryllium). José-Maria Mallen-Herrero (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucleaires, Saclay). July 1964. 112p. Dep.(mn).

Thesis submitted to Université, Paris.

The variation in the hot-ductility of as-extruded beryllium was studied, first of all, as a function of the temperature and of the rate of application of the tractive force. At 600°C intergranular brittle fractures were observed. The presence of a Portevin-Le Chatelier phenomenon in the region where the ductility decreases has made it possible for one to connect this brittleness with an impurity-dislocation interaction. Second, the influence has been studied of various thermal treatments on the ductility at 600°C, on the presence of the Portevin-Le Chatelier phenomenon, on the aspect of the fracture, and on the formation of a face-centered cubic product (a = 6.07 Å) whose presence is accompanied by an improvement in the ductility. The existence of a correlation between these different parameters is shown. The use of an electronic probe micro-analyzer and of x rays has made it possible to show that the role of the three main impurities is of prime importance in the mechanism of the hot-brittleness of commercial grade beryllium, the iron in solution being responsible for the impurity-dislocation interaction, the aluminum and the silicon being present in the form of a ternary Be–Al–Si eutectic with a melting point of 430°C. As a result of suitable thermal treatments, the iron migrates towards the liquid phase of the eutectic, situated at the grain boundaries, and forms a face-centered cubic Be–Al–Fe compound with a = 6.07Å. This has two consequences: the matrix becomes more liable to deformation and the liquid phase disappears to give way to a high melting-point compound. These two effects result in a notable improvement in the hot-ductility of commercial grade beryllium. (auth)

7898 (DMIC-Memo-179) SHORT-TIME TENSILE PROPERTIES OF THE Co–20Cr–15W–10Ni COBALT-BASE ALLOY (L-605). C. J. Slunder (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 27, 1963. Contract AF33(616)-7747. 145p.

Tables and graphs are presented for the short-time tensile properties of Haynes 25 Alloy. The data are grouped into four sections dealing with room-temperature tensile properties, short-time elevated-temperature tensile properties, tensile properties of welded and brazed joints, and tensile properties at cryogenic temperatures. A bibliography is included. (D.L.C.)

7899 (EURAEC-1112) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Sixth Quarterly Report. W. Siegfried and S. Zimering (Battelle Institut e. V., Frankfurt am Main). [1964]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 100-62-12 RDS. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Representation of the speed of creep as an exponential function of real order of the stress for steels is discussed. A method for the determination of the parameters is established and simplified for use on a computer. The variation of the parameters with the temperature for chromium–molybdenum steel and carbon steel is analyzed. A preliminary program is being established for the execution of in-pile creep tests in order to clarify the question of how far extrapolation methods can be applied under the influence of neutron radiation. (N.W.R.)

7900 (EURAEC-1192) STUDY OF BASE METAL TO BE USED IN RESEARCH ON BRITTLE FRACTURE OF LARGE WELDED ASSEMBLIES. Quarterly Report No. 1.

(Institut de Recherches de la Siderurgie, St.-Germain-Enlaye, France). Aug. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 031-64-5-GEEF (RD). 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Preliminary results are presented for the chemical analysis, hardness, and micrography of the skin and heart of a thick Super Elso steel plate. The results show that the plate is homogeneous throughout its thickness. (D.L.C.)

7901 (EURAEC-1261) MECHANISMS OF DIFFUSION AND PRECIPITATION OF HYDROGEN IN ZIRCONIUM. WORK HARDENING AND RECOVERY PHENOMENA IN ZIRCONIUM. (Bologna. Universita). [1963]. Work Performed under United States–Euratom Joint Research and Development Program. Contract 051-62-11-RDI. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A preliminary analysis of the work-hardening and recovery phenomena in zirconium has been carried out through electrical resistivity measurements and x-ray and electron microscopical observations. Work hardening proceeds through two stages: in the first, all the physical properties observed, that is, resistivity, line breadth, and dislocation density vary considerably while in the second only electrical resistivity varies. This last fact shows that as deformation increases, the defects introduced are mostly point defects. Recovery, too, proceeds through two stages: the first, characterized by a 30 kcal/mol activation energy, is attributed to migration and annihilation of vacancies essentially on dislocations. The second, coinciding with recrystallization, is characterized, in its initial phase, by a 52 kcal/mol activation energy, in agreement with the self-diffusion value found by Lyashenko et al. Finally, from the electron microscopical determination of dislocation density for low deformations, a contribution of dislocations to resistivity of the order of magnitude of 10^{-17} Ω cm^3 has been calculated in agreement with recent data of other authors. (auth)

7902 (GA-4617(Pt.1)) ADVANCED, GRAPHITE-MATRIX, DISPERSION-TYPE FUEL SYSTEMS. Quarterly Progress Report for the Period Ending September 30, 1963. J. C. Bokros, W. V. Goeddel, J. R. Hooker, H. K. Lonsdale, J. L. White, and L. R. Zumwalt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 30, 1963. Contract AT(04-3)-167. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Techniques have been developed for determining the density, crystallite size, layer spacing, and crystallographic orientation of pyrolytic carbon deposited in a fluidized bed. Characterization of pyrolytic carbons deposited over the range 1400 to 2100°C gave the following results: density was at a minimum in the 1600 to 1700°C range; the crystallite size increased uniformly with temperature of deposition; and preferred orientation data indicated that a highly oriented structure was deposited at 1400°C, random structures (almost isotropic) were produced at 1650°C (the density minimum), and slightly oriented structures were produced at temperatures above the density minimum. Other experiments indicated that variations in bed geometry and hydrocarbon partial pressure at constant temperature can also alter the structure of the deposits. Apparatus is being constructed with which to measure the mechanical properties of these pyrolytic carbons, so that the relationship between the structure of the deposits and their physical and mechanical properties may be determined. More complete data were obtained on the physical properties of graphite bodies (containing ZrC particles) hot-worked to moderate strain levels (approximately 30% in compression). Micrographic examinations of the hot-worked bodies indicated apparent improvements in microstructure as well as reduced porosity; however, no substantial improvement in permeability or in strength of the bodies was observed. The possibility that the samples were weakened during machining of the physical-property test specimens is being investigated. Removal of volatiles from pitch by either solvent extraction of pyrolysis continued to result in improvement in the properties of hot-pressed graphite compacts. Indications were that the material removed by volatilization during prepyrolysis was the same as that removed by petroleum-ether extraction, i.e., the moltene fraction. The method used in the past to measure the bulk diffusion coefficients in the uranium–pyrolytic carbon system proved unsatisfactory because of edge effects and, presumably, macroscopic graphite imperfections. Measurements have been made that demonstrate the existence of significant surface migration in this system at temperatures as low as 1000°C. Experiments have been planned for the thorium–pyrolytic carbon system in which the recognized limitations of the previous method will be corrected. Fission-product release studies were performed on a series of fuel compacts that had been impregnated to various levels of permeability. No apparent correlation was found between the fission-product release and the permeability of the compacts. (auth)

7903 (IS-925) ELASTICITY AND INTERNAL FRICTION THROUGH THE KILOCYCLE RANGE: REVIEW AND ANNOTATED BIBLIOGRAPHY. M. O. Marlowe and D. R. Wilder (Ames Lab., Ames, Iowa). June 1964. Contract W-7405-eng-82. 133p. Dep.; $4.00(OTS).

A review of techniques and fundamentals of Young's modulus and internal friction measurements is presented. The effect of porosity on elasticity is extensively reviewed as are factors contributing to internal friction. An annotated bibliography of 377 entries covering elasticity and internal friction measurements through the kilocycle frequency range is included and accompanied by a keyword index. (auth)

7904 (IS-986) THE CREEP OF THORIUM NEAR ROOM TEMPERATURE. D. T. Peterson and J. D. Young (Ames Lab., Ames, Iowa). Sept. 1964. Contract W-7405-eng-82. 24p. Dep.; $2.00(OTS).

The rate of plastic deformation of thorium was investigated as a function of stress and strain at temperatures from 0 to 60°C. The rate of creep or plastic deformation was found to depend on the instantaneous values of the stress, strain, and temperature and thus could be expressed by a mechanical equation of state. The yield point phenomenon was observed even at the lowest plastic strain rates. A critical stress was found below which no plastic deformation was observed. (auth)

7905 (LADC-6199) THE PLUTONIUM–SILICON SYSTEM. C. C. Land, K. A. Johnson, and F. H. Ellinger (Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The principal characteristics of the plutonium–silicon system include five intermediate phases and three eutectics. The intermediate phases are nominally Pu_5Si_3 (ζ), Pu_3Si_2 (η), PuSi (θ), Pu_3Si_5 (ι) and $PuSi_2$ (κ), which melt, respectively, at 1377, 1441, 1576, 1646 and 1638°C, all ±10°C. Crystal structure data for the intermediate phases are given. The eutectics were found at 3.6 at. % silicon and 590 ±2°C, between ϵ-plutonium and ζ; at 54.5 at. % silicon and 1521 ± 10°C, between θ and ι; and at 83.6 at. % silicon and 1232 ± 5°C, between κ and silicon. The solubility of silicon in δ and ϵ-plutonium is discussed in detail. (auth)

7906 (NAA-SR-Memo-9622) PULSE HEATING. M. W. Halseth (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 11, 1964. Contract AT-11-1-GEN-8. 19p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

An analysis was made of pulse heating experiments designed to provide hydrogen evolution, heat capacity data, and other information about zirconium hydride at high temperatures. A simple model reproduced the temperature profile and history of certain samples during the experiment. Gaps in the present knowledge of the behavior of zirconium hydride have been pointed out to provide the basis for further studies and experiments. (auth)

7907 (NAA-SR-Memo-10457) MODULUS OF RUPTURE AND TENSILE STRENGTH OF SiGe ALLOYS. G. G. Bentle and R. M. Kniefel (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 17, 1964. Contract [AT(11-1)-Gen-8]. 8p. Dep. (mn); $1.00(cy), 1(mn) OTS.

The modulus of rupture and the tensile strength of Si–Ge alloys made by casting and by hot-pressing were measured. The ranges of values for the cast material were: modulus of rupture, 6,000–10,000 psi; and tensile strength, 3,000–5,000 psi. The ranges of values for the hot-pressed material were: modulus of rupture, 15,000–16,000 psi; and tensile strength, 7,000–11,000 psi. The strength of the hot-pressed material is significantly higher than that of the cast material. This difference is attributed primarily to the smaller grain size of the hot-pressed material. (auth)

7908 (NP-14592) INVESTIGATION OF THE PSEUDO-TERNARY SYSTEM UC–UN–UO. Jack L. Henry (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Nov. 16, 1964. 12p.

A study is being conducted of the subliquidus phase relationships in the pseudo-ternary system UC–UN–UO. Single phase solid-solution areas within the system may offer attractive possibilities for high temperature reactor fuels. Preliminary data indicate a single phase area approximately bounded by the compositions UC–$U(C_{0.85}O_{0.35})$–UN. Compositions external to this area contain free uranium and uranium dioxide. UC and UN form a continuous series of solid solutions whereas the solubility of UO in UC is limited to about 35 mole percent. The solubility of UO in UN appears to be very small, perhaps as low as 1 or 2 mole percent. (auth)

7909 (TID-21430) THE TRUE STRESS-STRAIN PROPERTIES OF BRITTLE MATERIALS TO VERY HIGH TEMPERATURES. Final Report (1963–1964). (Southern Research Inst., Birmingham, Ala.). Oct. 30, 1964. Contract AT(40-1)-2694. 94p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The research program for FY 1964 included the continued refinement and automation of the stress-strain facility, the evaluation of refractory materials, the development of 6500°F graphite and 5000°F tungsten furnaces, and the study of Poisson's ratio and shear properties for brittle materials. Tensile property measurements are reported for a ZrB_2–$MoSi_2$ material, with-grain ATJ graphite, and pyrolytic graphite. Stress-strain relations for graphite are given. (D.L.C.)

7910 (UCRL-7824) ISOTHERMAL TRANSFORMATION STUDY OF SOME URANIUM-BASE ALLOYS. C. A. W. Peterson, W. J. Steele, and S. L. DiGiallonardo (California. Univ., Livermore. Lawrence Radiation Lab.). Aug. 1964. Contract W-7405-eng-48. 28p. Dep.; $2.00 (OTS).

Isothermal time-temperature-transformation characteristics are presented for the gamma phase of alloys of uranium with molybdenum, niobium, and zirconium. The changes in hardness and microstructure are described and correlated with the time, as determined by resistivity measurements, to initiate transformation at a given temperature. (auth)

7911 (WADD-TDR-60-143(Pt.V)) RESEARCH STUDY TO DETERMINE THE PHASE EQUILIBRIUM RELATIONS OF SELECTED METAL CARBIDES AT HIGH TEMPERATURES. R. V. Sara and C. E. Lowell (Union Carbide Corp. Carbon Products Div., Parma, Ohio). June 1964. Contract AF33(657)-8025. 65p.

Results are presented of investigations of phase equilibria in the binary systems, tantalum–carbon, hafnium–carbon, and boron–carbon. A completed phase diagram is presented for the hafnium–carbon system. A phase diagram for the tantalum–carbon system is included, which, in general, resembles the version released by Ellinger in 1943. Preliminary studies on the hafnium carbide–tantalum carbide quasi-binary were limited to temperatures of 3700°C at which no liquid formation was evident. Results for the boron–carbon system, depicting maximum boron solubility in the graphite lattice at and near the eutectic temperature of approximately 2390°C, are also included. Determination of the hafnium–carbon phase diagram by metallographic and x-ray diffraction studies on appropriate alloys constituted the bulk of effort for this period. The only intermediate phase observed in this binary system was HfC. This phase was found to be homogeneous between 34.0 and 48.0 atomic per cent at 2200°C and between 36.0 and 49.3 atomic per cent carbon at 3150°C. The lattice parameter variation was also determined for HfC_{1-x} compositions prepared at 2200 and 3150°C. The most refractory composition with a melting point at 3830°C, was established at 47.5 atomic per cent carbon from melting point data. Solidus temperatures of 2240 and 3150°C occur on the high hafnium and high carbon sides of the monocarbide, respectively. The invariant point between HfC and C is located at 66.0 atomic per cent carbon, whereas, the 2240°C solidus corresponds to the peritectic temperature at which β–Hf is formed from HfC and hafnium-rich liquid. β–Hf has a melting temperature of 2208°C and is capable of taking carbon into solution to the extent of 10.5 atomic per cent at this temperature. The tantalum–carbon system is characterized by two high temperature phases, TaC and Ta_2C. A eutectic is observed at 2825°C and 12.5 atomic per cent carbon between TaC and Ta_2C. Ta_2C has low carbon limits of 26.5 and 29.0 atomic per cent at 2850 and 3150°C, respectively. The Ta_2C phase field boundary apparently does not deviate from the stoichiometric composition on the high carbon side. A peritectic reaction at 3240°C leads to formation of Ta_2C from tantalum-rich liquid and TaC. TaC is face-centered cubic and has boundary limits of 41.7 and 49.5 atomic per cent carbon at 2250°C. The phase field broadens at higher temperature as exemplified by limits of 39.5 and 49.8 atomic per cent carbon at 3240 and 3375°C, respectively. The eutectic formed between TaC and C corresponds to 3375°C and 61.2 atomic per cent carbon. TaC, containing 49.8 atomic per cent carbon, melts in the temperature region of 3600°–3700°C. The highest melting temperature for TaC is above 3800°C when the carbon content is approximately 48.5 per cent. Preliminary studies on the HfC–TaC solidus were limited to four specimens and temperatures below 3700°C. Experimental difficulties prevented melting point measurements. A solid solution of boron in graphite was found and the limits of solubility as a function of temperature were determined. The solubility reached a maximum of 2.35 atomic per cent at 2350°C. The lattice constants varied with boron content as follows: $a_0 = 2.46023 + 0.00310\ K_B$ and $c_0 = 6.71163 - 0.00594\ K_B$, where K_B is the atomic fraction of dissolved boron, c_0 and a_0 being measured in angstroms. A comparison of measured and calculated densities of the solutions indicated that they were substitutional. (auth)

7912 (AWRE-Trans-47) EFFECT OF POROSITY ON THE ELECTROPHYSICAL PROPERTIES OF CERAMICS. I. S. Filatov. Translated by F. E. Wallwork (U.K.A.E.A. Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.), from Izv. Vysshikh Uchebn. Zavedenii, Fiz., No. 3, 107-11(1959). 11p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

It is shown that with increasing porosity of ceramic material the dielectric loss angle and permittivity increase in strong electric fields, whereas tan δ and ϵ in weak electric fields decrease with increasing porosity. This increase in tan δ and ϵ is linked to ionization processes of gas in the ceramic's pores. (auth)

7913 SPECIAL HEAVY CEMENT WITH HIGH ABSORPTION PROPERTIES. K. S. Kutateladze and A. V. Rustambekov. At. Energ. (USSR), 17: 515-16(Dec. 1964). (In Russian)

Descriptions are given of a heavy high-absorption concrete consisting of 60 to 75% lead slag and 25 to 40% portland clinker with 5% gypsum. The concrete has superior water retention and higher absorption than ordinary concrete. Water retention tests at 50 to 300°C showed retention equal to portland cement. The high absorption and low cost of material recommend the material for use in nuclear installations. (R.V.J.)

7914 ACTION OF SODIUM CITRATE AND SODIUM BORATE ON THE POLARIZATION CHARACTERISTICS OF URANIUM AND STEEL. Milton Levy and Philip Wong

(United States Army Materials Research Agency, Watertown, Mass.). Electrochem. Technol., 2: 290-4(Sept.-Oct. 1964).

Sodium citrate (0.1% in water) behaves primarily as a cathodic polarizer, although some anodic depolarization was observed. This increased cathodic polarization caused a marked reduction in the current flow between the anodic and cathodic members. The more electropositive potential of the short-circuited couple is also a contributing factor. The maximum reduction in current as noted in current-flow data occurred when uranium was the anodic member of the couple. Upon reversal of polarity (steel anodic), the current flow increased, although it leveled off at a value considerably lower than that associated with the untreated system. From these data, it appears that sodium citrate is more effective on uranium than steel. Sodium citrate in concentrations greater than 0.1% behaves as a corrosion accelerator in tap water primarily by anodic depolarization. At these concentrations, steel was the anodic member of the couple, uranium the cathodic member. Sodium decaborate in concentration of 0.1% exhibited a marked reduction in current flow. This inhibition of current flow is attributed to cathodic polarization where steel was the anodic member of the couple, uranium the cathodic member. At concentrations greater than 0.1%, steel was the cathodic member of the couple and uranium the anodic member. The polarization curves showed that the cathodic slopes were relatively flat and unchanged by increasing concentration, while the anodic slopes were steep and increased or decreased with increasing concentration. Therefore, sodium decaborate in concentrations greater than 0.1% behaves as a corrosion inhibitor in tap water by anodic polarization. (auth)

7915 TUNGSTEN BASE ALLOYS WITH LOW THERMAL EXPANSION COEFFICIENT. (2ND REPORT) ON THE MECHANICAL PROPERTIES OF SINTERED W–Ni–Fe ALLOYS. Hisasuke Takeuchi and Tatsuo Abe. Funtai Oyobi Funmatsuyakin, 10: 189-97(1963). (In Japanese)

Results of a study concerning the effects of sintering W–Ni–Fe compacts containing 90 to 97% W are analyzed. Properties such as density, electric conductivity, and hardness were determined along with tensile properties. Results indicate that several of the sintered W–Ni–Fe alloys can be cold rolled. (J.R.D.)

7916 DIFFUSION IN SOLID METALLIC SOLUTIONS OF Ni_3Nb–Ni_3Ta COMPOUNDS. I. I. Kornilov and A. Ya. Shinyaev. Izv. Akad. Nauk SSSR, Met. i Gorn. Delo, No. 5, 108-11(Sept.-Oct. 1964). (In Russian)

Diffusion parameters of Ni were determined, with the use of ^{63}Ni, for 20 to 100% Ni_3Nb at temperatures from 850 to 1303°C. The results indicated that in the solution the bond is typical of the metallic compounds present. The activation energy changed monotonically from the value for one component to that for the other. The change in E_{dif} took place chiefly around the 50% composition. If either component was present in amounts >75%, the value of E_{dif} was close to that for the main component. (IIC-M.G.)

7917 NIOBIUM SELF-DIFFUSION IN MONOCRYSTALLINE AND MELTED SPECIMENS. V. D. Syubimov, P. V. Gel'd, and G. P. Shveikin. Izv. Akad. Nauk SSSR, Met. i Gorn. Delo, No. 5, 137-41(Sept.-Oct. 1964). (In Russian)

The self-diffusion coefficient of Nb, determined with ^{95}Nb, diffused very little in monocrystalline and molten samples and increased exponentially with increasing temperature. This coefficient in metallic Nb depended on the metal porosity and changed with change in the activation energy. Before the coefficient-energy correlation can be used, more precise data are needed. (IIC-M.G.)

7918 TITANIUM AND ZIRCONIUM CARBIDE COATINGS ON GRAPHITE. A. L. Burykina and T. M. Evtushok. Izv. Akad. Nauk SSSR, Met. i Gorn. Delo, No. 5, 147-9 (Sept.-Oct. 1964). (In Russian)

Graphite was coated with titanium or zirconium carbides by covering it with molten titanium or zirconium metal and annealing. The carbide is stably bonded to the graphite, as shown by photomicrographs. Physical data are presented for samples annealed at 1500 to 1800°C, and lattice constants for Ti and Zr carbides are given. (IIC-M.G.)

7919 EFFECT OF CESIUM VAPOR ON THE EMISSION CHARACTERISTICS OF URANIUM CARBIDE AT ELEVATED PRESSURES. Philip W. Kidd (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 36: 14-17(Jan. 1965). (LADC-6344)

The saturated emission currents from uranium carbide in cesium vapor were measured for four different bath temperatures T: 167, 197, 227, and 250°C (the cesium arrival rates μ_a, in 10^{19} atoms/cm^2, were 0.3, 1, 3, and 6, respectively). The measurements were made with a plasma anode tube at constant temperature. The plot of $\log\mu_a$ vs 1000/T was used to extrapolate the electron emission S curves to arrival rates that differed by a factor of ten. Since calculations based on the assumption of a homogeneous surface yield unexpectedly high binding energies and surface coverages, it seems likely that some surface patchiness exists. (auth)

7920 HIGH-TEMPERATURE ELECTRICAL RESISTIVITY AND ALLOTROPIC TRANSFORMATION TEMPERATURE OF HAFNIUM. Ray G. Bedford (Univ. of California, Livermore). J. Appl. Phys., 36: 113-17(Jan. 1965). (UCRL-7520)

The electric resistivity of a Hf filament containing 4.9 at. % Zr was measured in the temperature interval from 1155 to 2250°K. The resistivity increases from 37 μΩ-cm at room-temperature to 187 μΩ-cm at 2025°K where the alloy undergoes a transition from an h-c-p to a b-c-c structure with a corresponding decrease in resistivity to 173 μΩ-cm. From data in the literature the transition temperature of pure Hf is estimated to be 2030 ± 30°K. Graphs of total emissivity versus temperature indicate that changes in the surface characteristics of the sample occurred during the measurements. After surface conditions became constant, the total hemispherical emissivity increased linearly with temperature from about 0.26 at 1200°K to 0.31 at 2000°K. (auth)

7921 AVALANCHE-INDUCED NEGATIVE RESISTANCE IN THIN OXIDE FILMS. K. L. Chopra (Kennecott Copper Corp., Lexington, Mass.). J. Appl. Phys., 36: 184-7(Jan. 1965).

A current-controlled negative resistance phenomenon, similar to that exhibited by a gas discharge tube, was observed in suitably prepared thin oxide films of Nb, Ta, and Ti, sandwiched between thin-film metal electrodes, at frequencies up to 1 Mc. The voltage required to sustain the negative resistance in both directions of current is independent of the electrode materials, apparent area and thickness (up to 500 Å) of the oxide film, and is about 0.4, 1.3, and 3.5 v for Ti, Nb, and Ta oxide films, respectively. The corresponding electric fields are approximately 0.8×10^6, 3×10^6, 9×10^6 v/cm. These values increase slightly with decrease of temperature. Experimental evidence supports the interpretation of the phenomenon in terms of avalanche multiplication of carriers in a thin region of the oxide film attended by space-charge-limited flow conditions. (auth)

7922 A PRESSURE-INDUCED FCC-TO-BCC TRANSFORMATION IN STRONTIUM. Franz K. Wedeling (Army Research Office, Durham, N. C.). J. Appl. Phys., 36: 328-9(Jan. 1965).

A previous report of a b-c-c high-pressure phase of normally f-c-c strontium is discussed, and a possible explanation of this pressure-induced transformation to a structure with lower packing density is considered. (C.E.S.)

7923 PHONON SPECTRUM OF GRAPHITE. James A. Young and Juan U. Koppel (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Chem. Phys., 42: 357-64(Jan. 1, 1965). (GA-5325)

The phonon spectrum of reactor grade graphite was computed by means of the essentially exact root sampling technique for a sampling 47,788 points in an irreducible segment of the Brillouin zone. Measurements of the spe-

cific heat (over the range 100–1000°K) were used to determine the force constants, resulting in good agreement of the calculated phonon spectrum, and neutron scattering measurements. (auth)

7924 TORSION EFFUSION STUDY OF THE VAPOR PRESSURE AND HEAT OF SUBLIMATION OF GALLIUM. Zuhair A. Munir and Alan W. Searcy (Univ. of California, Berkeley). J. Electrochem. Soc., 111: 1170-3(Oct. 1964). (UCRL-11062)

The vapor pressure of gallium was measured by the torsion effusion method between 1174 and 1603°K. The pressure, in atmospheres, is given by the expression: log $P = 5.5458 - (13743/T)$ in that temperature range. The heat of sublimation of gallium was calculated by the third-law method to be 65.4 kcal. A second-law determination was in reasonable agreement. (auth)

7925 THE TEMPERATURE DEPENDENCE OF THE FIELD COEFFICIENT FOR THE ANODIZATION OF TANTALUM. R. Dreiner (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 111: 1350-5 (Dec. 1964).

The temperature dependence of the field coefficient B in the relation for the high field ionic current, $i = i_0 \exp[BF-(W/kT)]$, was investigated for the anodic oxidation of tantalum. Results from constant voltage and constant current anodizations demonstrate that B is inversely proportional to the absolute temperature as expected for a barrier theory which predicts $B = a \cdot q \cdot/kT$. For the half jump distance, a, an average value of about 1.5Å was found when q was assumed to be equal to the charge on the five valent Ta-ion. (auth)

7926 THERMODYNAMICS OF THE PLUTONIUM–ZINC SYSTEM. I. Johnson and M. G. Chasanov (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 26: 2059-67 (Dec. 1964).

The thermodynamics of the zinc-rich portion of the plutonium–zinc system was studied with a high-temperature galvanic cell method. The free energy, enthalpy, and entropy of formation of the zinc-rich intermetallic compound, $PuZn_{12}$, at 500°C are -39.8 kcal mole^{-1}, -73.3 kcal mole^{-1}, and -43.4 cal deg^{-1} mole^{-1}. The relative partial molal enthalpy and excess partial molal entropy of plutonium in dilute zinc solutions are -44.7 kcal mole^{-1} and -24.6 cal deg^{-1} mole^{-1}. The solubility of plutonium in liquid zinc was measured and may be represented by the empirical equation: $\log x = 6.612 - 10090\ T^{-1} + 1.461 \times 10^6\ T^{-2}$, where x is atom fraction of plutonium. The magnitude of the thermodynamic quantities are discussed in terms of possible localized bonding and cluster formation in the liquid solution. The thermodynamics of three systems Th–Zn, U–Zn, and Pu–Zn are compared. (auth)

7927 CONCRETE IN THE NUCLEAR AGE. D. Campbell-Allen (Univ. of Sydney). J. Inst. Engrs., Australia, 36: 279-84(Oct.-Nov. 1964).

Properties of concrete as they relate to nuclear power generation are reviewed. Design and construction of biological shielding of concrete, containment vessels of concrete, and prestressed concrete pressure vessels are described. Organization for standardization and research and applications to Australian conditions are discussed. (M.C.G.)

7928 INTERMEDIATE PHASES IN THE TECHNETIUM–ALUMINUM AND TECHNETIUM–SILICON SYSTEMS. J. B. Darby, Jr., J. W. Downey, and L. J. Norton (Argonne National Lab., Ill.). J. Less-Common Metals, 8: 15-19(Jan. 1965).

Phase studies were made of the Al–Tc and Si–Tc systems. Data indicated that there are at least 4 intermediate phases in the Al–Tc system and at least 5 in the Si–Tc system. (M.C.G.)

7929 CREEP PROPERTIES OF THE Nb–1% Zr ALLOY. H. E. McCoy (Oak Ridge National Lab., Tenn.). J. Less-Common Metals, 8: 20-35(Jan. 1965). (ORNL-P-139).

Creep rupture properties of two heats of Nb–1% Zr were determined. Although these materials had comparable chemical analyses and were reported to have the same fabrication history, their creep strengths were considerably different. It was found that, at a test temperature of 982°C and at high stresses, a fine precipitate formed, which was oriented normal to the applied stress. At 1204°C, the precipitate was quite coarse and, again was preferentially oriented normal to the applied stress. It was found that pretest annealing at temperatures up to 1700°C markedly improved the strength without decreasing the rupture ductility. (auth)

7930 DISPERSION-STRENGTHENED ZIRCONIUM ALLOYS. K. C. Antony and H. H. Klepfer (General Electric Co., Pleasanton, Calif.). J. Less-Common Metals, 8: 36-46(Jan. 1965).

Inert particle strengthening concepts were extended to zirconium-base alloys. By using powder metallurgy techniques inert particles of Y_2O_3 were mechanically dispersed in a Zircaloy-2 matrix. Hot-hardness, elevated-temperature tensile, 343°C creep, and 400°C steam corrosion data for the resulting materials were obtained and interpreted. The elevated temperature yield strength of Zircaloy-2 was increased. Much of the increase was related to oxygen contamination. However, significant strengthening, in excess of that caused by oxygen, was shown to be caused by inert particle dispersion. The 343°C, steady-state creep rates of dispersion-strengthened Zircaloy-2 were markedly lower than those for wrought Zircaloy-2. Yttria dispersants were noted to have some adverse effect on corrosion resistance in 400°C steam. Oxygen contamination was the major technological problem with regard to the development of dispersion-strengthened zirconium powder metallurgy materials. Alloy additions of Be are suggested as a means of minimizing both the corrosion and oxygen contamination problems. (auth)

7931 X-RAY DIFFRACTION STUDY OF IMPERFECTIONS IN RHENIUM. C. N. J. Wagner and E. N. Aqua (Yale Univ., New Haven). J. Less-Common Metals, 8: 51-62(Jan. 1965).

An analysis was made of the broadening of the powder pattern peaks from rhenium powders exhibiting different strength properties in the green compacts and from deformed rhenium sintered sheet. The primary source of the line broadening was the small particle size of the crystallites; broadening attributed to lattice distortions was small or negligible. Evidence was found for growth faults on the (002) planes in the samples studied, and most significantly in the powder of the low green strength briquet (one fault every 100 (002) planes) and in the deformed sheet rhenium. (auth)

7932 THE SELENIDE AND TELLURIDE SYSTEMS OF NIOBIUM AND TANTALUM. E. Revolinsky, B. E. Brown, D. J. Beerntsen, and C. H. Armitage (Allis-Chalmers Research Labs., Milwaukee). J. Less-Common Metals, 8: 63-71(Jan. 1965).

A phase study of the Nb–Se, Nb–Te, Ta–Se, and Ta–Te systems was conducted. Powder x-ray diffraction was the principal tool of identification but single crystal techniques were used where possible to further characterize many of the phases found. Within the composition limits of MX to MX_3, evidence for seven phases was found in the Nb–Se and Ta–Se system. Within the same limits there appeared to be three phases in the Ta–Te and Nb–Te systems. The structures found at the MX_2 composition are layer-like and can be considered as being made up of varying numbers of "layer molecules" within which the cations have either distorted octahedral or regular trigonal prismatic anion coordination. The lower selenides and tellurides, MX-MX_2, seemed also to have a layer character with the excess metal atoms probably located in octahedral holes between the layers. The triselenides and tritellurides were apparently not layered structures. (auth)

7933 THE HIGH-TEMPERATURE SOLID SOLUBILITY LIMIT OF CARBON IN TANTALUM. E. Fromm and U. Roy (Max-Planck-Institut fur Metallforschung, Stuttgart). J. Less-Common Metals, 8: 72-4(Jan. 1965).

Studies were made of the terminal solubility of carbon in tantalum. Cylindrical specimens of high-purity tantalum were either brought into close-fitting contact with carbon in a graphite hollow cylinder or suspended freely in a graphite crucible. Annealing times were chosen sufficiently long to reach more than 90% saturation in the center of the specimens. A composite carbide layer formed on the surface of the sample and an island of α solid solution in the center. The amount of Ta_2C precipitate was distributed homogeneously over the area of the α phase. The outside carbide layers were mechanically removed and the core of the α phase was analyzed chemically. The solubility limit was appreciably higher than was previously reported. (M.C.G.)

7934 PREPARATION, IDENTIFICATION, AND CRYSTAL STRUCTURE OF SmAl. O. J. C. Runnalls and G. W. Lorimer (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Less-Common Metals, 8: 74-6(Jan. 1965).

Single crystals of the intermetallic phase SmAl were formed on an Al_2O_3 surface during an attempt to produce single crystals of samarium metal. Electron probe and x-ray fluorescence techniques were used to determine the chemical composition of the crystals. Powder diffraction data were also obtained. It was concluded that samarium-rich SmAl crystallizes with the body-centered cubic B_2 type structure containing one formula weight per unit cell, an Sm–Al distance of 3.24Å, and a calculated density of 5.63 g/cm^3. (M.C.G.)

7935 STRAIN-AGEING OF A SOLUTION-HARDENED NIOBIUM ALLOY. B. Harris and D. E. Peacock (Pratt and Whitney Aircraft, North Haven, Conn.). J. Less-Common Metals, 8: 77-9(Jan. 1965).

As part of a study of the mechanical properties of a niobium alloy containing 20 wt % Ta, 15 wt % W, and 5 wt % Mo, some yield-point-return experiments were performed. The alloy was deformed in tension at a constant strain rate to the end of the Lüders strain and aged in baths of oil or Wood's Metal at temperatures between 90 and 200°C until a slight yield drop was observed. The yield point failed to return after several days at room temperature but returned within a few seconds at 200°C. (M.C.G.)

7936 HIGH-PRESSURE HIGH-TEMPERATURE SYNTHESIS OF A NEW β-WOLFRAM COMPOUND Mo_3Sn. D. H. Killpatrick (Sandia Lab., Albuquerque, N. Mex.). J. Phys. Chem. Solids, 25: 1499-1500(Dec. 1964).

A β-wolfram compound, Mo_3Sn, was found after annealing Mo–Sn alloy samples for 2 hr at or above 1900°C. A β-wolfram lattice parameter of 5.094 ± 0.002 Å was obtained by x-ray measurements. The body-centered cubic alloy had a lattice parameter of 3.165 ± 0.005 Å. Tests indicated that Mo_3Sn is not superconducting above 0.35°K. (M.C.G.)

7937 DETERMINATION OF THE PORE STRUCTURE OF GRAPHITE. PART II. RESULTS. E. G. Schlosser (Farbwerken Hoechst AG, Frankfurt am Main). Kerntechnik, 6: 450-6(Oct. 1964). (In German)

Investigations were made of the pore structure of several graphites treated in different impregnation processes, and those of pyrolytic graphite and vitreous graphite. The gas permeability of pyrolytic graphite, and especially at vitreous graphite, was extremely low, and so was the permeability of some impregnated graphites. For impregnation, a multi-stage technique proved as effective as a process of only one or two stages. In some processes a decrease of porosity was obtained by reducing the open pore diameters, in others some of the pores are plugged. In nearly all graphites very dense surface coats contribute toward low permeability. (auth)

7938 SOME DIELECTRICAL PROPERTIES OF THIN FILMS OF PRASEODYMIUM FLUORIDE. K. Bertulis and V. Tolutis (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 381-7(1964). (In Russian)

Results of the investigation of the temperature and frequency dependence of both dielectric losses and the dielectric constant in thin (0.2 – 2.0 μ) films of praseodymium fluoride are presented. The anomalous polarization is found to have a relaxation character with an energy of activation of relaxation of 0.6 ev. The value of forbidden band, the dependence of dielectric constant, and the intensity of a breakdown field are determined according to the thickness of the films. (auth)

7939 THE METASTABLE PHASES OF THE URANIUM–NIOBIUM SYSTEM. STUDY OF THEIR HEAT TREATMENT. M. Anagnostidis, M. Colombie, and H. Monti (CERCA, Bonneuil/Marne, France). Mem. Sci. Rev. Met., 61: 737-51(Nov. 1964). (In French)

Two simultaneous reactions occur during the heat treatment of metastable phases of the α-type in Nb-U alloys. The relative importance of these reactions seemed to be independent of the crystal type of the initial phase but was closely connected with the morphology of the metastable phase. (auth)

7940 MECHANICAL PROPERTIES OF LOW-CONCENTRATION URANIUM ALLOYS. J. Laniesse, H. Aubert, and P. Le Bret (Commissariat à l'Energie Atomique, Saclay, France). Mem. Sci. Rev. Met., 61: 761-7(Nov. 1964). (In French)

Strength, deformation resistance, lifetime, and creep rate for remelted commercial uranium and Sicral alloys, after heat treatment for alpha grain refining, were determined. The mechanical properties of alloys containing silicon were substantially improved. (auth)

7941 THE SYSTEMS SILVER–YTTRIUM AND SILVER–SAMARIUM. E. Gebhardt, M. V. Erdberg, and U. Luety (Max-Planck-Institut für Metallforshung, Stuttgart). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 303-14(1964).

The phase diagram of these alloys was determined by the following methods: microscopy, x rays, hardness, and thermal analysis. In each system three intermetallic compounds were found. The structure of these compounds could be established in most of the cases. The system Ag–Y has four eutectic reactions and the system Ag–Sm has three eutectic reactions and one peritectic reaction. The solubility of Sm and Y in Ag is relatively small (about 0, 5 at.%), and temperature-dependent. Work is being done to determine the possibility of precipitation hardening. (auth)

7942 THE PHYSICAL AND MECHANICAL PROPERTIES OF BERYLLIDES. A. J. Stonehouse, R. M. Paine, and W. W. Beaver (Brush Beryllium Co., Cleveland). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 445-55(1964).

The intermetallic compounds between beryllium and a number of transition element metals were shown to possess properties of interest to high-temperature reactor design. The zirconium-beryllium and niobium-beryllium systems contained the compounds of most interest to reactor applications and, therefore, were the subject of the more intensive research effort, but a number of other compounds were characterized and studied. The actinide beryllides along with those rare earth beryllides prepared and not show oxidation resistance at high temperatures comparable to a number of the other beryllides. Compounds such as UBe_{13} were isomorphic with $ZrBe_{13}$ and solid solutions up to the equimolar composition were found to possess excellent high-temperature oxidation resistance. The beryllides generally possessed excellent strength to temperatures in the region of 2750°F as indicated by the results of modulus of rupture and tensile testing, which are presented. Data are also presented for the thermal conductivity, thermal expansion, specific heat, and melting points of the principle beryllides examined for possible utilization in high-temperature reactor systems. (auth)

7943 OXIDATION OF THE BERYLLIDES AT INTERMEDIATE TEMPERATURES—ANOMALOUS BEHAVIOR AND A SOLUTION. R. M. Paine, A. J. Stonehouse, W. W. Beaver (Brush Beryllium Co., Cleveland). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 495-509(1964).

Investigations as to the nature and elimination of inter-

mediate-temperature failure of the beryllides are described. The temperature range over which the oxidation strength, and thermal-shock resistance problems manifest themselves is dependent upon the particular material but is in the range of 1000 to 2000°F. Among the beryllides, the problems appear to be limited to the zirconium beryllides and, to a lesser extent, to the niobium beryllides. In oxidation tests at eight intermediate temperatures (800–2000°F) excellent resistance was shown by $TaBe_{12}$, Ta_2Be_{17}, $MoBe_{12}$, $TiBe_{12}$, and WBe_{12}. Experimental evidence is presented, which shows that the addition of aluminum or aluminum-containing compounds to hot-pressed bodies of $ZrBe_{12}$, Zr_2Be_{17}, $NbBe_{12}$, and Nb_2Be_{17} imparts excellent oxidation resistance to these materials at intermediate temperatures where they would normally undergo severe accelerated oxidative attack. Possible mechanisms for intermediate-temperature failure, as well as the mechanism through which oxidation resistance is achieved by aluminum additions are discussed. A number of beryllides showed exceptional promise for service as structural components for high-temperature (above 2300°F) applications. The favorable nuclear properties of most of these compounds make them attractive for use in nuclear reactor systems, where attempts are being made to increase operational temperatures. As a class, the beryllides were found to possess good strength, good oxidation resistance, and high thermal conductivity at projected operational temperatures (2500°F). However, at certain intermediate temperatures between about 1000 and 2000°F, certain beryllide preparations showed failure, which in most cases could be attributed to poor oxidation resistance in this temperature range. The problem was studied and some of the limits of its manifestations defined. Some insight into the mechanism of failure was gained and one solution to the problem was found and investigated. (auth)

7944 THORIUM–URANIUM CARBIDES FOR COATED-PARTICLE GRAPHITE FUELS. E. S. Bomar and R. J. Gray (Oak Ridge National Lab., Tenn.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 703-28(1964).

A description and pertinent results of research and development on thorium–uranium carbides for coated-particle, gas-cooled reactor graphite fuels are presented. The areas considered are as follows: pyrolytic-carbon-coating studies, in- and out-of-reactor evaluation of coated-particle materials, phase relationships in the Th–U–C system, microstructure of coated particles, impurity content of the particles, compatibility of carbides with pyrolytic carbon, and techniques for metallographic preparation and examination of reactive thorium–uranium carbides both before and after irradiation. Extensive investigation was made of the particle/coating interactions, as a function of time and temperature, and the effects of phase transformations on the performance of these materials under reactor conditions. An assessment of failure mechanisms indicated that the effects of particle swelling and fission recoils are of major significance. (auth)

7945 NEW REPRESENTATIVES OF THE $NbAs_2$ AND $ZrAs_2$ STRUCTURES. F. Hulliger (Cyanamid European Research Inst., (Cologne and Geneva Nature, 204: 775 (Nov. 21, 1964).

Data and discussion concerning the structure of compounds with orthorhombic $ZrAs_2$-type and monoclinic $NbAs_2$-type phases are presented. (J.R.D.)

7946 FISSION-PRODUCT RELEASE FROM MONOGRANULAR UC_2 PARTICLES. L. R. Zumwalt, P. E. Gethard, and E. E. Anderson (General Dynamics Corp., General Atomic Div., San Diego, Calif.). Nucl. Sci. Eng., 21: 1-12(Jan. 1965).

The fission-product release of spherical monogranular UC_2 particles was studied by post-irradiation annealing of neutron-activated samples and by exposing samples to a steady rate of photofission. The release of the fission products considered appears to follow the kinetics and temperature dependence of an activated diffusion process. The anomalous fast release of a portion of the ^{133}Xe in annealing experiments may be interpreted as being due to release of attached or trapped Xe atoms by a process not following Fick's law. Diffusion coefficients for Kr, Te, I, Xe and Ba in UC_2 (in cm^2/sec) were obtained by analysis of the data. The diffusion coefficient for Xe in UC_2 shows agreement with the diffusion coefficient for Xe in UO_2. A negative activation entropy (–13 eu) for diffusion is indicated. (auth)

7947 THE ELECTRICAL CONDUCTIVITY OF ALUMINA AT TEMPERATURES IN A REACTOR ENVIRONMENT. Gary J. Dau and Monte V. Davis (Univ. of Arizona, Tucson). Nucl. Sci. Eng., 21: 30-3(Jan. 1965).

The electric conductivity of a 0.085-cm-thick layer of flame-sprayed alumina was examined as a function of temperature and of the specific power of an operating nuclear reactor. It was determined that the electric conductivity of the alumina can be expressed as $\sigma(T,P) = \sigma_1 \exp(-a_1/T) + \sigma_2 \exp(-a_2/T) + \sigma_3 PT^{\frac{1}{2}}$. The first term on the right is the normal expression for ionic conductivity as a function of temperature. The second term accounts for the impurity conduction in the insulator, and the third term assumes an ionized material in which Rutherford scattering plays a dominant role in the mobility of the electron-hole pairs created by photon interactions in the alumina. The assumption of electronic conductivity, a temperature-dependent mobility varying as $T^{\frac{1}{2}}$, and a density of charge carriers proportional to the reactor specific power P is seen to hold over a temperature range up to 1300°K and up to reactor specific powers of 6 kw/liter. An extrapolation of the results to higher specific power shows that the conductivity of Al_2O_3 is adequate for nuclear thermionic systems. (auth)

7948 REACTIONS OF REACTOR-IRRADIATED URANIUM MONOCARBIDE WITH WATER AND WITH AQUEOUS SOLUTIONS OF NaOH, HCl, AND H_2SO_4. Mildred J. Bradley, Jerry H. Goode, Leslie M. Ferris, James R. Flanary, and Jacob W. Ullmann (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 21: 159-64(Feb. 1965). (ORNL-P-620)

Reactor irradiation of uranium monocarbide (UC) caused pronounced effects on its reactions with water and with aqueous solutions of NaOH, HCl, and H_2SO_4. Specimens irradiated to a burnup of 0.6 at. % or higher were essentially inert to water and to 6M NaOH at 80°C. When the burnup was 0.06 at. % the specimens hydrolyzed, but the rates were much lower than those obtained with unirradiated specimens. The irradiation had little effect on the rates of reaction with HCl and H_2SO_4. When hydrolysis of irradiated UC occurred in water, 6M NaOH, 6M HCl, or 6M H_2SO_4, the gases evolved contained less methane, less total volatile hydrocarbons and more hydrogen than the gases evolved from unirradiated UC under the same conditions. In general, with increasing burnup of the UC, the amount of hydrogen evolved increased while the amounts of methane and total carbon recovered in the gas decreased. (auth)

7949 THERMAL CONDUCTIVITY OF BORONATED GRAPHITE AND POWDERED BORON CARBIDE. C. F. Bonilla (Columbia Univ., New York) and A. J. Friedland. Nucl. Struct. Eng., 1: 7-13(Jan. 1965).

Results of thermal conductivity measurements on two grades of boronated extruded graphite, both parallel and perpendicular to the direction of extrusion, are presented. Other data are included on the thermal conductivity of powdered boron carbide at 500 to 1000°F. (J.R.D.)

7950 ON THE BINARY ALUMINUM-RICH COMPOUNDS OF THE RARE-EARTH. J. H. N. van Vucht and K. H. J. Buschow. Philips Res. Rept., 19: 319-22(1964).

The rare-earth metals R are found to form RAl_3 compounds, RAl_4 compounds, or both. This behavior is briefly discussed together with relations in structure between the RAl_3 compounds. (auth)

7951 RESISTANCE TRANSITIONS OF SUPERCONDUCTING LEAD–INDIUM ALLOYS. W. F. Druyvesteyn and J. Volger. Philips Res. Rept., 19: 359-77(Aug. 1964).

In an experimental study of Pb–In alloys in the type-II superconducting state, magnetic and electric properties

were determined. It was found that the magnetization curves in longitudinal fields are in agreement with the GLAG theory. Emphasis was put on the investigation of the resistive behavior. The critical current zero field is given by a kind of Silsbee relation which H_{C1} should be inserted for the critical field. The resistivity found in the mixed state appears to be governed by a Lorentz-force term IH sin φ. It can be explained by viscous motion of flux. In the R vs H curves a sharp increase of resistance is found which probably marks the end of the mixed state. The resistance transition for $H > H_{C2}$ can be explained by a simple model in which a residual superconducting region is shunted by the normal part of the material. The experimental value of H_{C3} is found to be in agreement with the calculations of Saint James and De Gennes concerning the surface superconductivity. (auth)

7952 ASYMMETRIES IN SUPERCONDUCTOR-NORMAL METAL TUNNELLING JUNCTIONS. G. J. van Gurp and A. P. van Gelder. Philips Res. Rept., 19: 400-2(Aug. 1964).

Asymmetric i-v characteristics of evaporated superconductor-normal metal tunnelling junctions were found, probably due to a metallic bridge between the superconductor and the normal metal. (auth)

7953 RESISTIVITY OF SOLID AND LIQUID SODIUM. Michael P. Greene and Walter Kohn (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: A513-22(Jan. 18, 1965).

A theoretical study of the resistivity of solid and liquid sodium is reported. Inelastic neutron scattering data are used to obtain the required information about the ion dynamics. The electron-phonon interaction is characterized by phase-shifts η_l, two of which are used as adjustable parameters. Although the calculation is believed to incorporate accurately many-body effects, umklapp processes, and time-dependent effects, agreement with experiment is disappointing. The calculated resistivity exceeds the experimentally measured values by a factor of the order of 2 at low temperatures, and above the melting point there are again discrepancies of this order. No convincing explanation of these disagreements was found. (auth)

7954 OPTICAL PROPERTIES OF GRAPHITE IN THE REGION 1100 TO 3000 Å. J. G. Carter, R. H. Huebner, R. N. Hamm, and R. D. Birkhoff (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A639-41(Jan. 18, 1965). (ORNL-P-180)

The optical properties of hot-pressed pyrolytic graphite were studied in the wavelength region from 1100 to 3000 Å. The real (n) and imaginary (k) parts of the complex index of refraction were obtained from reflectance measured at 20 and 70° incidence. The complex dielectric constant and the energy-loss function were determined from these values of n and k. The energy-loss function, $\mathrm{Im}(1/\epsilon)$, was found to exhibit a maximum at a wavelength of 1800 Å corresponding to an energy of 6.9 ev. This peak corresponds to the 7.5-ev loss in electron energy-loss experiments, where it was attributed to the excitation of the conduction-electron plasma. (auth)

7955 RESISTIVITY, MAGNETORESISTANCE, AND MAGNETIZATION OF DILUTE ALLOYS OF IRON IN $Mo_{0.8}Nb_{0.2}$. Myriam P. Sarachik (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., 137: A659-63 (Jan. 18, 1965).

The resistivity, magnetoresistance, and magnetization were measured for nine alloys of iron in $Mo_{0.8}Nb_{0.2}$, with iron concentrations from 0.2 to 2.3%. Minima are observed in the resistivity-versus-temperature curves in the range 28 to 38°K, depending on concentration. Both the temperature-independent impurity scattering and the spin scattering are proportional to concentration for low concentrations, and the spin resistivity is found to be a logarithmic function of the temperature. The magnetoresistance is negative in all cases, and is proportional to the square of the magnetization. These results lend support to a recent theory proposed by J. Kondo, which predicts both the linear dependence of the spin scattering on concentration and its logarithmic dependence on temperature. Using this theory, the s-d exchange integral is found to be negative and equal to −0.2 ev. (auth)

7956 BAND STRUCTURE AND MAGNETISM OF GADOLINIUM METAL. J. O. Dimmock (Massachusetts Inst. of Tech., Lexington) and A. J. Freeman. Phys. Rev. Letters, 13: 750-2(Dec. 21, 1964).

Results of a nonrelativistic augmented plane wave calculation of the electronic energy bands in gadolinium metal are reported. The calculated conduction bands differ markedly from those of the free-electron model, and instead closely resemble those of the transition metals. This is due to the fact that bands originating from atomic 5d and 6s states overlap and are strongly mixed. The bands near the Fermi surface are of mixed s-d character and yield a density of states about three times that given in the free-electron model. This accounts for the large observed saturation magnetization of Gd metal and may account for the high electronic specific heats of rare-earth metals. (C.E.S.)

7957 DILUTE-ALLOY ANTIFERROMAGNETISM IN $Fe_{05}Au_{95}$. Paul P. Craig (Brookhaven National Lab., Upton, N. Y.) and William A. Steyert. Phys. Rev. Letters, 13: 802-4(Dec. 28, 1964).

Mössbauer studies of $Fe_{.05}Au_{.95}$ as a function of temperature and of external magnetic field are reported. It is shown that the ordering in this alloy is antiferromagnetic. From Mössbauer polarization measurements it is found that at temperatures well below the magnetic transition and in the presence of external magnetic fields of 34 kOe the Fe spin orientation remains almost random, and there is little tendency toward spin orientation either parallel or antiparallel to the external field. Thus the possibility of ferrimagnetic as well as ferromagnetic ordering is excluded for this alloy. (C.E.S.)

7958 WORK FUNCTION OF Nb–Ta, Ti–Re, AND Ta–Re ALLOYS. B. Ch. Dyubua, O. K. Kultashev, and I. A. Tsyganova. Radiotekhn. i Elektron., 9: 2061-5 (Nov. 1964). (In Russian)

Constitution diagrams were constructed for Nb–Ta, Ti–Re, and Ta–Re alloys, and their work function dependence on component content and phase composition was measured at temperature from 1400 to 2300°K. The wave function of Nb–Ta (after degasification at 1900°K) was 4.0 to 4.1 ev and for Ti–Re, 4.1 ev. Wave function of Ta–Re alloys (degased at 1800 to 2000°K) and heated to 2300°K ranged from 4.15 to 4.25 ev. (R.V.J.)

7959 METALS AND ALLOYS WITH HIGH MELTING POINTS, AND POSSIBILITIES OFFERED BY THEIR HEAT-TREATMENT. H. Braun (Climax Molybdenum Co., Zurich). Rev. Met. (Paris), 61: 867-76(Oct. 1964). (In French)

The mechanical properties of Nb, Mo, Ta, and W are described. Hardening by producing solid solutions or mixed phases and by work hardening is discussed. Thermochemical diffusion processes for improving mechanical properties are considered. Films to provide the metals protection against oxidation are described. (auth)

7960 COLD-ROLLED AND RECRYSTALLIZED TEXTURES OF MOLYBDENUM SHEETS. Masahiko Ishizaka (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., 18: 1415-25(Dec. 1963). (In Japanese)

The variations in texture of powder-metallurgy cold-rolled Mo sheets were investigated by measuring their pole figures. Variations during recrystallization were investigated by measuring the principal diffraction lines. Crystal structure results and texture observations are included. (J.R.D.)

7961 THERMOCHEMICAL PROPERTIES OF THE LAVES PHASE, Cr_2Ta. P. Feschotte and O. Kubaschewski (National Physical Lab., Teddington, Middx., Eng.). Trans. Faraday Soc., 60: 1941-6(Nov. 1964).

The temperature of transformation, from the C15 to the C14 type, of Cr_2Ta was found to lie between 1600 and 1640°C. X-ray work indicated that the solubility of chromium in tantalum is larger than that of tantalum in chromium. The heat of formation of Cr_2Ta was determined at 1420°C in a high-temperature calorimeter as −2040 ± 120

cal/g atom. The activities of chromium in various chromium-tantalum alloys were measured by means of an effusion technique. The free energy of formation of Cr_2Ta at 1199°C is −2200 ± 120 cal/g atom. The entropy of formation is thus slightly positive, namely, +0.11 ± 0.16 cal/g atom deg. (auth)

7962 MODIFICATIONS IN THE CRYSTAL STRUCTURE PARAMETERS OF U WITH TEMPERATURE AND THEIR INFLUENCE ON SOME PROPERTIES OF URANIUM. C. Nagabhushana Rao and K. Tangri (Atomic Energy Establishment, Trombay, India). Trans. Indian Inst. Metals, 16: 93-103(June 1963).

The angle of corrugation in the a-c plane, bond lengths and bond orders, and sizes of interstitial holes in the structure of alpha U have been calculated as functions of temperature. The angle of corrugation shows no tendency to open up at higher temperatures. The bond-orders show that the change of principal slip system at higher temperatures is not a direct consequence of the change of bond orders with temperature. Tyzack's suggestion that the sizes of the 'octahedral' and 'pyramidal' holes in the lattice would become equal at about 500°C, in order that the irradiation growth in the [010] direction would reverse at about 500°C, is incorrect as shown by the values of the hole diameters at different temperatures. (auth)

7963 INVESTIGATION OF CERTAIN URANIUM OXIDES. L. M. Kovba, E. U. Kuz'micheva, and E. A. Ippolitova. Vestn. Mosk. Univ., Ser. II, Khim., No. 3, 34-6 (May-June 1964). (In Russian)

Results of experiments to determine the phase composition of tetragonal uranium oxides and of decomposition products of $UO_4 \cdot 2H_2O$ were inconclusive. The tetragonal oxide $\beta-U_3O_7$ was obtained by oxidation of UO_2 in air at 250°C. At 300 to 400°C, $UO_2 + U_3O_8$ gave U_4O_9, not tetragonal oxides. Reduction of $UO_2 + U_3O_8$ gave a cubic phase with a fluorite lattice, and reaction of it with sulfuric acid gave a uranium oxide with a hexagonal lattice. Photomicrographs of $\beta-U_3O_7$ heated 500 hr at 400°C and $UO_2 + U_3O_8$ heated 100 and 500 hr at 400°C showed coarse, irregular crystals. (IIC-M.G.)

7964 STRUCTURAL STUDIES ON SOME ALLOY SYSTEMS HOMOLOGOUS AND QUASI-HOMOLOGOUS TO T^4-T^9. Aravamudhan Raman and Konrad Schubert (Max-Planck-Institut fur Metallforschung, Stuttgart). Z. Metallk., 55: 704-10(Nov. 1964). (In German)

Phase relations in the alloy systems Ti−Rh, Zr−Rh, Hf−Rh, Ti−Ir, Zr−Ir, Hf−Ir, Ti−Pt, Zr−Pt, and Hf−Pt were studied by x-ray diffraction experiments. Several crystal structures found were analyzed and the rules characterising their formation are discussed. (auth)

7965 SUPERCONDUCTIVITY AND PHASE TRANSFORMATIONS IN TITANIUM ALLOYS. I. ADDITION OF VANADIUM + ALUMINUM, NIOBIUM AND MOLYBDENUM. Christoph Julius Raub and Ulrich Zwicker (Univ. of California, San Diego, La Jolla and Forschungsinstitut fur Edelmetalle, Schwabisch Gmund, Ger.). Z. Metallk., 55: 711-15(Nov. 1964). (In German)

The change of transition temperature during β/α transformation of the alloys TiV16A13, TiMo16 and TiNb33 was investigated. The transition temperature was influenced by the concentration of the alloying elements in the β-matrix and hence by the valence electron concentration. The influence of the ordered intermediate phases is small. The transition temperature of the α-solid solution could be increased by V(a) group elements, but in the alloys investigated the transition temperature of β phase was higher than that of the α phase and therefore the value for T_c corresponded to that of the β phase. The concentration of alloying elements in the β phase and thus the transition temperature could be shifted to higher or lower values by normal or up-hill diffusion during the transformation processes. (auth)

7966 MAGNETIC PROPERTIES OF GADOLINIUM−TERBIUM AND GADOLINIUM− ERBIUM ALLOYS. V. I. Chechernikov, Iuliu Pop, and I. V. Burov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1257-61(Oct. 1964). (In Russian)

The magnetic properties of Gd− Tb and Gd−Er alloys were investigated in the 77 to 1100°K temperature range. Maxima depending on the concentration and magnetic field strength are found in the $\sigma(T)$ curves. A dependence of the effective magnetic moment P_p and paramagnetic Curie point Θ_p on the composition of the alloy is established for Gd−Er alloys. (auth)

7967 QUATERNARY ALLOY Nb−Ti−ΣMo, V CROSS SECTION (WITH THE RATIO Mo: V = 3: 1). I. I. Kornilov and R. S. Polyakova. Zh. Neorgan. Khim., 9: 2416-23 (Oct. 1964). (In Russian)

A physico-chemical analysis of Nb−Ti−Mo−V alloy revealed a quasi-ternary cross section Nb, Ti, and ΣMo, V with Mo: V = 3:1. The quasi-ternary system crystallized as a continuous solid solution with a body-centered lattice and has a high electric conductivity. A phase diagram was constructed. (R.V.J.)

7968 THE NIOBIUM−TUNGSTEN−MOLYBDENUM−ZIRCONIUM ALLOYS. E. M. Savitskii and A. M. Zakharov. Zh. Neorgan. Khim., 9: 2424-32(Oct. 1964). (In Russian)

Microscopic, microhardness, x-ray, and thermal analyses were made of six initial tetrahedral cross sections of Nb−W−Mo− Zr, with 5, 7.5, 10, 15, 20, and 30 wt % of W, Mo, and Zr. The solidus surfaces were plotted at 2000, 1800, 1500, and 1100°C. The alloys exhibited single and double phase structures; single phase ternary solid solutions of W, Mo, and Zr in Nb and binary phases with saturated $(W,Mo)_2Zr$ crystals. (R.V.J.)

7969 THE SCANDIUM−ERBIUM AND SCANDIUM−CERIUM SYSTEMS. O. P. Naumkin, V. F. Terekhova, and E. M. Savitskii. Zh. Neorgan. Khim., 9: 2497-8 (Oct. 1964). (In Russian)

Phase diagrams were constructed for Er−Sc (with 98.16% pure Sc) and Ce− Sc (with 99.5% pure Sc). Differential thermal analysis was carried out with an order of accuracy of ±10% at temperature above 1300°C and ±5% at temperatures below 1000°C. Phase diagrams plotted according to microstructure and thermal and x-ray analysis are given. Examined alloys formed continuous solid solutions at room temperature. Cerium alloys with 17 at. % Sc are corrosion resistant in air at room temperature. (R.V.J.)

7970 THE CERIUM− GADOLINIUM− SYSTEM. I. V. Burov, V. I. Chechernikov, E. M. Savitskii, and Pop Iuliu. Zh. Neorgan. Khim., 9: 2594-8(Nov. 1964). (In Russian)

A study of the magnetic properties of Ce−Gd alloys in a paramagnetic field established the fact that these alloys did not obey the Curie−Weiss law. The results of thermomagnetic analysis were useful in constructing equilibrium phase diagrams. The results of thermal and thermomagnetic analyses compared satisfactorily. (tr-auth)

7971 X-RAY INVESTIGATION OF THE MODIFICATIONS II AND III OF NH_4Br AT TEMPERATURES BETWEEN 22° AND −125°C. V. Hovi, K. Heiskanen, and M. Varteva (Univ. of Turku, Finland). 20p. (CONF-651-31)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The lattice parameters of the modifications of NH_4Br at temperatures between 22 and −125°C were determined by using Debye-Scherrer method. The lattice parameters of the modifications were measured at seven and nine different temperatures for the bcc and tetragonal modifications, respectively. At 22°C, the measured lattice parameter of the bcc modification was 4.0574 ± 0.0005 A, whereas at −42°C and −125°C, the observed parameters of the tetragonal modification of NH_4Br were 5.725 ± 0.001 and 4.060 ± 0.001 A, and 5.709 ± 0.001 and 4.053 ± 0.001 A, respectively. The molar volume and thermal expansion coefficient of the modifications were calculated from the measured data as functions of temperature. At the transition between −37 and −42°C, the molar volume was found to increase by 0.40% with decreasing temperature. (P.C.H.)

7972 THE FLOW AND FRACTURE PROPERTIES OF UNIRRADIATED STAINLESS STEELS. H. F. Beeghly (Jones and Laughlin Steel Corp., Pittsburgh). 22p. (CONF-512-11)

From American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964.

Factors that may influence the engineering properties of stainless steels in the unirradiated condition are discussed. These include: chemical composition; manufacturing practices; and thermal treatment. Slides were made to compare the 100- and 10,000-hr stress-rupture information for austenitic steels. At 1200°F the 100- and 10,000-hr values for Type 304-L are 21.5 and 11.5 KSI, respectively. The values of uranium and boron as constituents of steel are also discussed. (P.C.H.)

7973 X-RAY DIFFRACTION OF NONMETALLIC PHASES CHEMICALLY EXTRACTED FROM COLUMBIUM ALLOYS. David P. Laverty and Ralph H. Hiltz (Thompson Ramo Wooldridge, Inc., Cleveland).

From 13th Annual Conference on Applications on X-Ray Analysis, Denver, Aug. 1964. 26p. (CONF-715-4)

In a study of alloy carbide dispersions in niobium, x-ray diffraction of the bulk samples could adequately identify the carbides present, but it was only by studying the chemically extracted residues that an important oxygen gettering effect of one of the alloy additions was discovered. In another study, x-ray diffraction work on extraction residues of Nb–Zr alloys showed evidence of a double oxygen gettering effect producing two distinct oxides. In the bulk sample, some of the diffraction lines produced by one of these oxides were masked by the lines of the niobium matrix. Therefore, only by use of an extraction technique were these two oxides identifiable by x-ray diffraction. In a Nb–10Ti–10Mo alloy, x-ray diffraction was used to study the nature of the subscale formed during oxidation of the alloy. At least two nonmetallic phases were found. By using chemical extraction techniques, the phase responsible for the formation of the subscale was identified as TiO. The studies demonstrate some of the advantages of the chemical extraction techniques for obtaining samples of nonmetallic phases for study by x-ray diffraction. (P.C.H.)

7974 HIGH-FIELD GALVANOMAGNETIC PROPERTIES OF RHENIUM. E. Fawcett and W. A. Reed (Bell Telephone Labs., Murray Hill, N. J.). 11p. (CONF-651-29)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The high-field galvanomagnetic properties of rhenium show that its Fermi surface supports at least two sets of open orbits. The open orbits along the hexagonal axis occur on an electron sheet having a mobility about one order of magnitude smaller than the mobility of the other sheets. The open orbits along the $\langle 10\bar{1}0 \rangle$ axes result from magnetic breakdown, and there is some evidence for a second set of open orbits along the hexagonal axis which involve the same sheet of the Fermi surface as the $\langle 10\bar{1}0 \rangle$ set. (auth)

Radiation Effects

Refer also to abstract 8616.

7975 (EURAEC-1218) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Quarterly Report No. XV, July 1–September 30, 1964. E. Anderson, D. Brandon, D. King, M. Malone, and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The general progress of the program is briefly surveyed and three selected topics are discussed in some detail. The design and construction of the high frequency internal friction apparatus is reported. Experimental results on the relationship between (grain diameter)$^{-\frac{1}{2}}$ and the lower yield stress are presented; it is concluded that this relationship is not linear and that discrepancies among the results of other workers may be at least partially reconciled by consideration of the grain size ranges studied. The application of field-ion microscopy to the program is reviewed and discussed. The field-ion microscope available for this work is described, together with the proposed course of this aspect of the research program. (auth)

7976 (EURAEC-1238) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 4, July 1–September 30, 1964. F. Rossi (Societa Ricerche Impianti Nucleair. Centro Ricerche Nucleari, Saluggia, Italy). Oct. 1964. Work Performed Under United States–Euratom Joint Research and Development Program. Contract 004-63-10-TEEI(RD). 20p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The influence of few ppm of titanium on the ductile-brittle transition temperature in the resilience tests was observed: the transition temperature is markedly lowered and the completely ductile fracture plateau is higher than the value obtained with Armco iron specimens. A good agreement with the Petch law was observed on specimens of the same Fe–Ti alloys. Internal friction results have been compared, with a good agreement, with analytical results of the nitrogen and carbon content in iron. Chemical determinations on low Fe–Ti alloys (few ppm of Ti) give evidence of a different behavior of the precipitated nitrogen depending on the thermal and mechanical history of the material. The study of the recovery of radiation damage by means of magnetic measurements in a first set of irradiated pure iron specimens has been completed. A new set of measurements has begun and a new irradiation has been done in RS1 SORIN Reactor. A comparison between magnetic results and internal friction measurements of specimens of very low interstitial content quenched from very high temperature has begun, to check whether the normal quenching temperature is sufficient to distribute into the lattice either the carbon bound to traces of impurities forming carbides, and the carbon anchored to grain boundaries and dislocations. (auth)

7977 (GA-5636) EFFECTS OF NEUTRON IRRADIATION ON MATERIALS SUBJECTED TO MULTIAXIAL STRESS DISTRIBUTIONS. Final Report. T. A. Trozera, P. W. Flynn, and G. Buzzelli (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Sept. 15, 1964. Contract AT(04-3)-167. 78p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The objective of this program was to study the effect of irradiation and combined stress states on the mechanical properties of a reactor pressure-vessel steel. The effect of an equal biaxial stress state on properties such as yield and flow strength and strain at instability was studied. Tests were made on tubes in which the ratio of principal stresses was two. In addition to the tube tests designed to study the effect of a combined stress state, tests were also performed in simple tension, on notched tensile bars, and on Charpy specimens. These tests were designed to provide both baseline information (simple tension tests) and information of more general use, such as dosimetry and Charpy results, which could be compared with results from other sites. The irradiations were all performed at reactor ambient temperature (<100°C) and postirradiation tests covered the temperature range 0 to 149°C. The specimens used to perform the tube tests were rather small-diameter thin-walled tubes. This was necessary because of the small capsule diameter and led to a number of problems. Much difficulty was experienced in obtaining tubes which met the required tolerances, and an even greater difficulty was that of measuring the wall thickness of the tubes. In addition to problems of this type, considerable scatter in properties was evidenced in specimens from the second heat of steel. This scatter made it impossible to apply a strength theory to results of the second irradiation. However, a number of worthwhile conclusions can be drawn from the data. A mathematical derivation of the instability

conditions for positive principal stress ratios of one and two was performed based on the Von Mises-Hencky strength theory and is presented. (auth)

7978 (GEAP-3694) POST-IRRADIATION EXAMINATION OF ALLIS CHALMERS (NSPR) CAPSULES I, II, & III. J. M. Gerhart (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Feb. 1961. For Allis-Chalmers Mfg. Co., Milwaukee. Contract AT(11-1)-589. 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A post-irradiation examination of nine aluminum-clad fuel specimens was made. The fuel specimens examined contained 95% dense UO_2 pellets clad with swaged 8001 alloy aluminum. The ^{235}U enrichment of the individual fuel specimens was 4.5%, 6%, and 7%. The fuel specimens were irradiated in the General Electric Test Reactor (GETR) to burnups ranging from 5530 to 10950 Mwd/t-UO_2 and at average heat fluxes ranging rom 263,000 to 463,000 Btu/hr-ft^2. Post-irradiation examination revealed cladding failure in four of the nine specimens. Measurement of active fuel length and individual pellet lengths was made using gamma scanning techniques and correlated with actual physical measurements. Post-irradiation measurement of the active fuel lengths showed the length to vary between 98 and 105% of the pre-irradiation length. The undefected specimens were punctured and fission gas release was found to range from 0.28% to 5.9%. Metallographic examination of three specimens revealed possible center melting in one specimen, indications of grain growth with no center melting in another, and neither center melting nor grain growth in the third. (auth)

7979 (KAPL-3076) FRACTURE TOUGHNESS OF IRRADIATED PWR HAFNIUM. D. F. Mowbray (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 10, 1964. Contract W-31-109-eng-52. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Fracture toughness tests were conducted on eight single-edge-notched specimens (0.232-in.-thick) removed from PWR control rods. Four of the specimens had received a total integrated neutron dosage of 7×10^{21} n/cm^2 (>0.625 ev), and four, 15×10^{21} n/cm^2 (>0.625 ev). The specimens were tested at temperatures between -320°F and room temperature. The results of the tests indicated that it was not possible to determine plane-strain fracture toughness of irradiated hafnium in the available section thickness by the pop-in technique, because of twinning deformation adjacent to the notch tip. The tests did, however, reveal: (1) that irradiated hafnium possesses adequate toughness for current control-rod applications, and (2) that there was essentially no difference in the brittle fracture resistance of the material at the two levels of neutron-irradiation dosage. (auth)

7980 (NRL-Memo-1468) IRRADIATION EFFECTS ON STRUCTURAL MATERIALS. Quarterly Progress Report, August 1-October 31, 1963. L. E. Steele, J. R. Hawthorne, and C. Z. Serpan, Jr. (Naval Research Lab., Washington, D. C.). Nov. 15, 1963. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Research is devoted to the determination of the effects of nuclear radiation upon the properties of structural materials. This report includes data on: effects of irradiation of ferritic steels to high neutron exposure (7×10^{19} n/cm^2 > 1 Mev); effects of cyclic irradiation-annealing treatments on A302-B and HY-80 steels; procedures for sampling of the Organic Moderated Reactor Experiment pressure vessel and core grid plate for neutron dosage determinations; notch ductility properties of uranium-bearing steels before irradiation; and a description of a supplementary technique for control of temperature of experimental assemblies during irradiation. (auth)

7981 (RISÖ-84) CLASSICAL SCATTERING CROSS SECTIONS FOR RADIATION-DAMAGE CALCULATIONS. II. THE BORN-MAYER POTENTIAL. P. Sigmund and P. Vajda (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). Aug. 1964. 23p. Dep.(mn); Jul. Gjellerup, 87, Solvgade, Copenhagen K, Denmark.

Differential cross sections are calculated for the Born-Mayer interatomic potential from classical scattering theory. At large angles, a matching method is used. The potential is cut off at a fixed distance in order to exclude many-body collisions. Certain cut-off methods are used to calculate small-angle cross sections. Interpolation between the small-angle and large-angle tails yields power cross sections with exponents varying between -1.0 and -1.5 for energies between 300 ev and 17 kev in Cu. This result is only slightly affected by the special choice of cut-off procedure and cut-off radius. It is shown that the concept of binary-collision cross sections becomes dubious at energies below 500 ev, even if it is modified by the inclusion of damping forces. (auth)

7982 (EURAEC-1095) THERMAL CONDUCTIVITY OF SINTERED URANIUM OXIDE UNDER IN-PILE CONDITIONS. Special Report No. 10. Jean-Pierre Stora, Bruno de Bernardy de Sigoyer, Roger Delmas, Pierre Deschamps, Bernard Lavaud, and Claude Ringot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. Work Performed under United States-Euratom Joint Research and Development Program. Contract 031-60-10-RDF. 117p. Translation of CEA-R-2586. Dep.(mn); $4.00(cy), 2(mn) OTS.

The temperature distribution in a stack of sintered UO_2 cylinders has been studied both in the laboratory where the heat energy is produced by an axial heating element, and in-pile. Under a high thermal gradient, the UO_2 cracks both along radial planes and along pseudo-cylindrical surfaces: these latter act as thermal barriers to the heat flow. It is therefore an apparent thermal conductivity $k_a(T)$, lower than the intrinsic value k(T) of this parameter which is measured. The efficiency of these barriers decreases when the gap decreases and when the external pressure acting on the cracked stack increases: in the limiting case, for high values of the binding strain, $k_a(T) \simeq k(T)$. In the domain of phononic conduction ($T \leq 1350°C$), the expression kw $cm^{-1}°C^{-1} = 1/(11 + 0.024\,T)$ accounts for the real thermal conductivity. Above 1350°C the thermal conductivity increases. Two in-pile measurements up to 1250°C carried out using cartridges fitted with thermocouples confirm, within the limits of experimental error, the above expression and the qualitative effects of the binding strains. Similar tests have been carried out-of-pile and in-pile on the real shape of the EL 4 fuel "pencils." Out-of-pile, the influence of the initial free gap, of the nature of the gas filling the "pencil" and of the external pressure have been studied; the results are compatible with the above interpretation. It appears that an external pressure of 60 kg/cm^2 is insufficient to restore completely the thermal conductivity of the fuel. (auth)

7983 DAMPING PEAKS IN NEUTRON-IRRADIATED Fe-0.01%C. H. Wagenblast and J. C. Swartz (United States Steel Corp., Monroeville, Penna.). Acta Met., 13: 42-4(Jan. 1965).

Several small damping peaks were detected in the internal friction spectra of irradiated iron containing carbon. (M.C.G.)

7984 ELASTIC PROPERTIES OF SOME GLASSES AFTER NEUTRON X IRRADIATION. Andre J. Paymal and Pierre Le Clerc (Saint-Gobain Research Center, Paris). J. Am. Ceram. Soc., 47: 548-54(Nov. 21, 1964).

Changes in Young's modulus brought about in various glasses by exposure to irradiation in a nuclear reactor are reported. The changes are a function of glass composition and particularly of the alkali content. A proposed interpretation of the changes observed at low doses is based on comparisons with the temperature ratio of Young's modulus and consideration is given to both a hot structural configuration and a rearrangement in cation sites. Changes observed at higher doses are explained by an increase in the specific gravity due to compaction and those at very high doses by tempering. (auth)

7985 COLOR CENTERS IN X-IRRADIATED SODA-SILICA GLASSES. Herbert L. Smith and Alvin J. Cohen (Mellon Inst., Pittsburgh). J. Am. Ceram. Soc., 47: 564-70 (Nov. 21, 1964).

The coloration produced by x irradiation in silicate glasses prepared under oxidizing and reducing conditions was studied. These glasses differed both in the position of the absorption maximums and in the thermal stability of the color centers formed. Maximums were observed at 4.10, 2.70, and 1.96 ev in oxidized glasses and at 2.15 ev in reduced glasses. Additions of a wide variety of cations to the basic glasses modified the coloration produced by x irradiation. These modifications appeared as new centers or in the enhancement or reduction of coloration produced by x irradiation in the base glasses. The reduction of ions such as Ce^{4+}, Eu^{3+}, and Yb^{3+} by x irradiation was observed. Although several of the color centers appeared to be associated with the glass network itself, there was some correlation between the added cations and the coloration of the glass by x irradiation. (auth)

7986 DOSE DEPENDENCE OF THE DISLOCATION BREAKAWAY STRESS IN NEUTRON-IRRADIATED COPPER AS MEASURED BY AMPLITUDE-DEPENDENT INTERNAL FRICTION. D. O. Thompson and V. K. Pare (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 36: 243-52(Jan. 1965). (CONF-524-4)

Measurements of the strain-amplitude dependence of the internal friction in copper were made at 100°C as a function of fast neutron dose. Although it is found that the Granato-Lücke theory of amplitude-dependent internal friction does not describe the results obtained, the dose dependence of the dislocation breakaway stress can be deduced by other means. After taking into account the variation with neutron dose of the mean free dislocation length, it is found that the breakaway stress is proportional to the cube root of the integrated flux in the dose range from 10^{11} to 10^{14} neutrons/cm^2 (E > 0.6 Mev). Extrapolation of the breakaway stress results to doses greater than 10^{19} neutrons/cm^2 shows essential agreement with earlier neutron-hardening results. The results are discussed in terms of a source-hardening mechanism. (auth)

7987 INFLUENCE OF NEUTRON IRRADIATION ON FIRST-ORDER DISPLACIVE TRANSITIONS IN QUARTZ AND CRISTOBALITE. Rustum Roy and C. P. Buhsmer (Pennsylvania State Univ., University Park). J. Appl. Phys., 36: 331-2(Jan. 1965).

Neutron-bombardment-induced disorders were investigated in high-purity quartz and well-ordered 3c-cristobalite. The α-β transition temperature in quartz is lowered monotonically with irradiation, the change amounting to 14°C for 2.4×10^{19} neutrons cm^{-2}. The high-low (cubic-tetragonal) inversion in cristobalite is even more extensively affected by exposure to a flux of 2.4×10^{19} neutrons cm^{-2}. The inversion temperature drops from 260 to 142.5°C. (C.E.S.)

7988 IRRADIATION BEHAVIOR OF SOLID SOLUTION URANIUM–PLUTONIUM MONOCARBIDES. A. Strasser (Union Nuclear Corp., White Plains, N. Y.), J. Cihi, W. Sheridan, and V. Storhok. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 729-52(1964).

Eight clad specimens of $(U_{0.8}Pu_{0.2})C_{0.95}$ were irradiated to two burnup levels (~5×10^{20} and 11×10^{20} fiss/cm^3 average) at average power levels of 330 to 530 w/cm. The experiments are described and results given. (auth)

7989 IRRADIATION EFFECTS IN URANIUM SULFIDE. L. A. Neimark and R. Carlander (Argonne National Lab., Ill.). Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 753-64(1964).

Pellets of $US_{0.95}$ were irradiated to investigate the behavior of uranium sulfide as a fuel material. Two types of pellets were irradiated: pellets sintered in argon to 80% of theoretical density, and pellets liquid-phase sintered in vacuum to 90% density. All pellets contained approximately 2 wt % residual UOS either as discrete particles in the 80% dense pellets, or as a US-UOS eutectic grain boundary phase in the 90% dense pellets. The specimens were clad with 0.30 mm Nb-1 wt % Zr and achieved burnups ranging from 2.9 to 8.2×10^{20} fiss/cm^3 at cladding surface temperatures from 400 to 790°C and surface heat fluxes from 250 to 360 w/cm^2. Diameter and volume changes of the clad specimens were less than 0.8% and 0.5%, respectively, except in one 80% dense pellet specimen where center melting occurred and a 2.8% diameter increase was measured at a circumferential bulge. Fission gas release was less than 1.2% except in the melted specimen, which released 20% of the theoretical gas yield. A Widmanstatten structure of very fine needles present in the unirradiated pellets tended to disappear in the highest temperature, highest burnup specimen. The loss of the needles at about 1700°C was confirmed by examination of a group of specimens made available from an investigation of the transient irradiation behavior of the same material. The needles were re-precipitated upon cooling from the molten state. Attempts are being made to identify the needles. (auth)

7990 EFFECTS OF FABRICATION AND COMPOSITION ON THE IRRADIATION STABILITY OF URANIUM CARBIDE. J. Crane (United Nuclear Corp., White Plains, N. Y.), E. Gordon, and J. E. Gates. Met. Soc., Am. Inst. Mining, Met. Petrol. Engrs., Inst. Metals Div., Spec. Rept., No. 13, 765-84(1964).

The irradiation behavior of cast uranium carbide containing 4.4, 4.8, and 5.2 wt % carbon and of sintered carbide containing 4.4 and 4.8 wt % carbon was evaluated at burnups from 14,000 to 40,000 Mw-d/ton U(1 at. % burnup is roughly equivalent to 7,500 Mw-d/ton U) and a heat flux of 24 to 37 kw/ft. The data indicated that 5.2 wt % carbon fuel can withstand burnups to 38,000 Mw-d/ton U at 1100 to 1200°C with release of only 5% of the total fission gas formed and with diametral swelling of 1.5% per at. % burnup. The 4.8 wt % carbon material showed somewhat poorer behavior but was substantially better than the 4.4 wt % carbon fuel. For all practical purposes, uranium carbide was found to be compatible with Nb-1 wt % Zr (used as the canning material) to 1000°C for 9000 hours exposure. (auth)

7991 BURNUP AND FISSION GAS RELEASE RATE DETERMINATIONS ON IRRADIATED UO_2 FUEL. Isao Fujji, Noboru Oi, Tadao Ohno, and Haruo Muto (Shibaura Electric Co., Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 6: 637-45(Nov. 1964). (In Japanese)

Chemical examinations were being made on the natural UO_2 pellets which were irradiated in GETR for one and two months respectively. The pellets were contained in a stainless steel inner capsule and an Al outer capsule; the activities when they arrived were 40 and 120 C, respectively. The determination of the release rate of gaseous fission products (^{85}Kr) and burnup calculations were performed on these samples. The release rate of ^{85}Kr was determined by comparing the activities of fission gases trapped when the capsules were drilled in a vacuum container with those trapped from melting pieces of the pellets. The rate was 0.1 ~ 0.13% which means that gaseous fission products were very well retained in these UO_2 pellets. The burnup values were determined by using ^{137}Cs as an indicator and were 0.06 to 0.13%, respectively. These data agreed very well with calculated values from the activities of Al-Co monitoring wires which were irradiated while attached to the capsules. The chemical analysis of various parts of pellets was made and no relocation of ^{137}Cs was noticeable. (auth)

7992 COMPARISON OF NEUTRON EMBRITTLEMENT OF STEEL IN DIFFERENT REACTOR SPECTRA. A. D. Rosin (Argonne National Lab., Ill.). Nucl. Struct. Eng., 1: 76-82(Jan. 1965).

A procedure was developed for measuring and reporting neutron exposure for radiation damage studies. The neutron spectrum shape is calculated and its magnitude determined by the reaction ^{54}Fe(n,p)^{54}Mn. A unit, called RDU, is used for reporting exposure. To test this procedure, steel specimens were irradiated in three very different reactor spectra. The exposures were expressed in RDU's and the resulting embrittlement compared. Satisfactory agreement was obtained. The procedure proved to be easy to use. A new method for reducing a limited amount of irradiation data was devised to handle irradiations done in a facility

where the neutron flux varied appreciably from place to place. (auth)

7993 THE RESPONSE OF p-i-n JUNCTIONS TO BETA RAYS. I. OPEN-CIRCUIT VOLTAGE VERSUS SURFACE DOSE RATE FOR PHOSPHORUS-32 AND THALLIUM-204. N. A. Baily and J. W. Hilbert (Hughes Research Labs., Malibu, Calif.). Phys. Med. Biol., 10: 42-50(1965).

The surface absorbed dose rate in polystyrene, delivered by various β sources, was compared with the response of lithium-drifted p-i-n junctions, as measured by the open circuit voltage induced across the junction by the β radiation. The potential induced across the junction under irradiation is conveniently measured by simple instrumentation and has higher sensitivity than other simple methods. The surface absorbed dose rate in polystyrene was measured at a point corresponding in each case to the center of the detector in a plane coincident with the detector surface; a thin-window parallel-plate extrapolation-type ionization chamber was used. The geometric factors influencing the ratio of the two measurements were investigated as a function of source-to-detector distance by varying detector area, source area, source thickness, and energy of the β spectrum. (auth)

7994 SCINTILLATION PROPERTIES OF ANTHRACENE AND NAPHTHALENE CRYSTALS IRRADIATED WITH α PARTICLES, DEUTERONS, AND ELECTRONS AT LOW TEMPERATURES. W. F. Kienzle. Thesis, Göttingen, Ger., Universität, 1964. 72p. $2.00(Gmelin, AED-DISS. 64-98). (In German)

The design and construction of a metal cryostat for scintillation studies in the temperature range from 1.5 to 300°K are described. The fluorescent yield for 7-Mev α rays in anthracene increases with falling temperature and reaches a constant value below 4°K. The α/β light yield ratio increases with decreasing temperature. This indicates that the quenching mechanism for strongly ionizing particles is temperature dependent. Results of measurements of light emission anisotropy in anthracene and naphthalene are given. Possible relations between scintillation anisotropy and crystal properties are discussed. (Gmelin Inst.)

7995 THE EFFECTS OF RADIATION ON NICKEL–CADMIUM BATTERY ELECTRODES. [PART] II. G. R. Argue, H. L. Recht, W. A. McCollum, and D. E. McKenzie (Atomics International, Canoga Park, Calif.). 27p. (CONF-407-9)

From Electrochemical Society, Toronto, May 1964.

A study of the effects of gamma radiation on nickel-cadmium cells was made with emphasis on the loss in capacity of the cadmium electrode and on the radiolysis of an aqueous KOH electrolyte. The previously reported loss of cadmium electrode capacity was confirmed. A total average gamma dose of 9.0×10^7 Rads (H_2O) caused a cadmium electrode, being cycled near 75% of full charge, to lose about 15% of its original capacity. The same dose caused essentially no loss in capacity of a fully charged cadmium electrode. A blank cell run at 45°C, the temperature inside the ^{60}Co source, showed no loss of capacity, indicating that this is not a temperature effect. Several attempts to restore the lost capacity were unsuccessful. It was tentatively concluded that gamma radiation causes an irreversible inactivation of some of the oxidized species, $Cd(OH)_2$, on the cadmium electrode. Experiments were carried out to study the radiolysis of aqueous KOH solutions at concentrations from 0.5% to 40%. Hydrogen and oxygen were evolved in a ratio of approximately 2:1 by volume at a concentration of 0.5% KOH. At concentrations from 10% to 40%, the amounts evolved of both gases were considerably reduced, with the oxygen being undetected in most samples. A mechanism is proposed to explain these results. Radiolysis of 30 per cent KOH containing a portion of a nickel electrode produced relatively large amounts of oxygen whereas only hydrogen was evolved during the irradiation of a similar solution containing a portion of a cadmium electrode. The proposed mechanism was used to explain these results. (auth)

7996 EFFECTS OF IRRADIATION IN AUSTENITIC STEELS AND OTHER HIGH TEMPERATURE ALLOYS. P. C. L. Pfeil and D. R. Harries (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 32p. (CONF-446-49)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Neutron irradiation has an adverse effect on the tensile ductility of austenitic steels and a nickel base alloy at test temperatures above about 600°C. In contrast to the fast neutron induced low temperature irradiation hardening and embrittlement of materials, the loss in ductility at elevated temperatures is a function of the thermal neutron dose and the effects cannot be recovered by post-irradiation annealing at temperatures up to about 1200°C. Similar detrimental effects on the elevated temperature tensile ductility are produced by irradiation at ambient temperatures and 650°C, respectively. The irradiation induced loss in the elevated temperature tensile ductility of a 20% Cr:25% Ni:Nb steel is preceded by the formation of fine carbide (and nitride) precipitates on dislocations and in grain boundary regions. The deleterious effects of irradiation on the high temperature properties are also manifested in post-irradiation stress-rupture and tube burst tests. The thermal neutrons are effective in producing the elevated temperature loss in ductility by forming new atoms in the lattice by transmutation processes. The results of tensile tests at 750°C on samples of 20% Cr:20% Ni:Ti stabilized steels impregnated with ^{10}B or ^{11}B show that the loss in ductility can be correlated with the number of helium and/or lithium atoms produced by the $^{10}B(n,\alpha)^7Li$ reaction. The magnitude of the radioinduced changes in the elevated temperature properties can be controlled to some extent by an initial cold working and annealing treatment which results in a fine grain size and coarse precipitates within the grains. (P.C.H.)

METEOROLOGY

7997 (CEA-R-2526) MESURES JOURNALIERES DE LA RADIOACTIVITE NATURELLE ET ARTIFICIELLE DANS L'AIR EN 1960. (Daily Measurements of Natural and Artificial Radioactivity in 1960). Jean-Claude Philippot (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). July 4, 1964. 30p. Dep(mn).

Daily numerical results of β activity of the air, either from natural, owing to thoron, or from artificial, owing to active aerosols origin, are given. All results are expressed in $\mu\mu$Curie/m^3 of air. (auth)

PHYSICS

General

Refer also to abstract 7686.

7998 (64-RL-3778E) SEMISTABLE QUADRUPOLE-OCTUPOLE PERIODIC UNITS. D. J. BenDaniel (General Electric Co. Research Lab., Schenectady, N. Y.). Sept. 1964. 11p.

Periodic magnetic fields whose potential is of the form $\varphi = z + A \sin z[I_0(r) + BI_2(r) \cos 2\theta + CI_4(r) \cos 4\theta]$ are considered. These fields have the property that the flux tube volume can decrease in the $\theta = 0$ plane and increase in the $\theta = \pi/2$ plane. Thus in an appropriately symmetrized system, closed surfaces of flux tube volume with negative gradient can be constructed. By properly adjusting the parameters B and C, an absolute minimum in flux tube volume can be achieved in the sense that the magnetic field is uniform at some radius in the $\theta = 0$ plane. (auth)

7999 (AD-342287) CLOSE-IN EFFECTS OF NUCLEAR EXPLOSIONS. PART I. PARTICLE-IN-CELL METHOD STUDIES FOR ONE- AND TWO-DIMENSIONAL SPACE-TIME PROBLEMS. Melvin L. Baron, Charles P. Lecht, and Richard Skalak (Weidlinger (Paul) Consulting Engineer, New York). May 1963. Contract DA-49-146-XZ-128. 138p.

A series of studies is presented on several variations of the Particle-In-Cell method as applied to the solution of problems in compressible fluid flow. A Sharp Shock procedure is formulated which allows for the propagation of sharp discontinuities at the wave fronts in the media without the spreading effects associated with the usual Particle-In-Cell approaches. The method is illustrated by applications to simulated excavation problems in one dimensional space-time geometries. The mathematical formulation of a two dimensional space-time problem involving a hydrodynamic model for the extreme close-in region of a nuclear explosion is also presented, together with an outline of the general computer formulation and flow charts for the problem. (auth)

8000 (EUR-2157.e) CALCULATION OF THE FRACTIONAL RELEASE OF GASES FROM A SLAB AFTER COIL BOMBARDMENT. G. Di Cola (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy) and Hj Matzke (Brunswick. Technische Hochschule Carolo Wilhelmina). 1964. 28p. Dep.(mn).

The problem of the release of recoil gas atoms from a slab (infinite plane sheet) of inert material during post-bombardment annealing is considered. Two initial conditions (rectangular and linearly decreasing concentration at t = 0) are assumed. Mathematical formulas for the fractional release F are derived and compared with experiments and literature. Using values obtained from a standard 7090 IBM electronic computer, figures and tables are given which relate F to a dimensionless function of the diffusion coefficient. (auth)

8001 (IITRI-1184-15) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 15, August 16, 1964–November 15, 1964. J. J. Markham (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Dec. 5, 1964. Contract AT(11-1)-587. 44p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A method for first saturating and then observing an inhomogeneously broadened EPR line is described. The results are reported for F-centers in KCl at 4°K. Only long saturation times leading to a steady state saturation are used. A saturation factor is defined as a function of the difference between the saturating and observing fields. A simple model based on the existence of spin packets does not explain the data even at very low saturating powers. A modification of the model for inhomogeneous broadening is suggested. The emission band of F-centers in rubidium chloride is reported for 4°K and 78°K. The shape is independent of temperature. From the moments and the temperature dependence of the width, the Huang-Rhys factor for emission is determined. (auth)

8002 (IS-954) PATTERSON SUPERPOSITION SYSTEM FOR THE IBM 7074. D. R. Fitzwater, T. R. Johnston, D. H. Erbeck, and M. K. Rhyne (Ames Lab., Ames, Iowa). Aug. 1964. Contract W-7405-eng-42. 26p. Dep.; $2.00 (OTS).

A system is described that aids in resolving the N(N-1) peaks that appear on a Patterson Map into the fundamental set of "N" vectors corresponding to the "N" atoms. (auth)

8003 (LAMS-3014) RADIATIVE AND CONDUCTIVE OPACITIES AND MONOCHROMATIC ABSORPTION COEFFICIENTS FOR AIR. Arthur N. Cox and John N. Stewart (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract W-7405-eng-36. 239p. Dep.; $6.00(cy), 4(mn) OTS.

The opacity of air was calculated by computer codes for the temperature range 0.5 to 2000 volts and the density range 10^{-9} to 10^{-1} g/cm^3. Thermodynamic equilibrium is assumed, and the effects of molecule formation is neglected. Monochromatic data with and without line absorption and coherent scattering are given in the form of D vs u and $k' + \sigma$ vs λ. The data are of good quality down to a temperature of 2 volts. (D.L.C.)

8004 (NASA-SP-3012) TABLES OF ENERGY LOSSES AND RANGES OF ELECTRONS AND POSITIONS. Martin J. Berger and Stephen M. Seltzer (National Bureau of Standards, Washington, D. C.). 1964. Contract R-80. 131p. $4.00 (OTS).

Tables are presented for approximately forty materials, and eightly energies between 10 kev and 1000 Mev, which contain the following information: mean energy loss of electrons by collisions with atomic electrons and by bremsstrahlung, the mean range, and the radiation yield (conversion of electron kinetic energy into bremsstrahlung energy). Auxiliary tables contain information about restricted collision losses in water, critical energies (at which the collision and bremsstrahlung losses are equal), and electron-positron differences in regard to energy loss and range. Some comparisons are made between calculated and experimental values of the mean energy loss. (auth)

8005 (NASA-SP-3013) TABLES OF ENERGY LOSSES AND RANGES OF HEAVY CHARGED PARTICLES. Walter H. Barkas (California. Univ., of Berkeley. Lawrence Radiation Lab.) and Martin J. Berger (National Bureau of Standards, Washington, D. C.). 1964. 135p. $4.00(OTS).

Two-variable proton stopping power and range tables are given as functions of the particle energy (τ) and of the mean excitation energy (I) of the medium for 160 values of τ between 1 and 5000 Mev, and for 36 values of I. These tables can be applied to any medium with specified mean excitation energy. By simple scaling, they can also be applied to other heavy particles with mass and charge different from that of the proton. The tabulated values below 8 Mev are based on experimental stopping-power and range data as summarized by a 9-parameter least-squares range formula. Above 8 Mev they are based on the Bethe stopping power theory (except for the shell corrections), which are calculated by an empirical formula in the variables τ and I derived from the analysis of experimental data. The two-variable tables do not include the density effect correction, which begins to be appreciable when the kinetic energy of the particle is approximately equal to the rest mass. Stopping power and range tables which include the density effect correction are given for protons, kaons, pions, and muons, for 36 elements and compounds. (auth)

8006 (NP-14536) DIRECT ENERGY CONVERSION SYSTEMS. SUPPLEMENT 2. TRANSPORT PROPERTIES OF PARTIALLY IONIZED MONATOMIC GASES. Quarterly Technical Summary Report, June 1–August 31,

1964. R. Stephen de Voto (Stanford Univ., Calif.). Sept. 30, 1964. Contract AF49(638)-1123. 66p.

Discussions are presented of special problems which arise in connection with calculations of the transport properties of partially ionized monatomic gases. The most serious problem concerns the lack of agreement of the usual thermal conductivity expression in the limit of full-ionization with other results derived explicitly for this case. It is shown that satisfactory agreement can be obtained in this limit if one uses the third rather than the second approximation in the Chapman-Enskog theory. Expressions for the fourth and lower approximations to the thermal conductivity, the thermal diffusion coefficient, and the ordinary diffusion coefficient of multicomponent gases are derived. The viscosity of this mixture is considered to the second approximation. It is shown that the thermal diffusion plays a very important role in an ionized gas. Neglect of this effect can cause the thermal conductivity to be seriously overestimated. An expression is presented which approximates the effect of the thermal diffusion on the thermal conductivity. The charged particle cross section is considered with the screened Coulomb potential. Cross sections derived with this potential should be accurate for denser plasmas that can be accurately considered with the usual Debye cut-off cross-section. Convergence of the higher approximation is checked by applying the formulas to the calculation of the properties of several special mixtures where the molecules obey the Coulomb and other inverse-power interaction potentials. (auth)

8007 (NYO-1480-3) MONTE CARLO STUDIES OF SYSTEMS OF HARD SPHERES. Aubey Rotenberg (New York Univ., New York. Courant Inst. of Mathematical Sciences). Oct. 1, 1964. Contract AT(30-1)-1480. 71p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Monte Carlo studies were carried out for systems of hard spheres in one (rods), two (disks), and three dimensions. The experiments are described in some detail along with the results. The existence of a phase transition in both two and three dimensions was confirmed. In an attempt to study the transition further, the effect of imposing a gravitational field on the system was investigated, and it was found that the field does not separate out the two phases. A possible model for what happens at the phase transition is suggested and discussed. (auth)

8008 (SC-DC-64-1595) TRANSIENT BASE PRESSURE STUDY OF AN AXISYMMETRIC SUPERSONIC MISSILE FLYING HEAD-ON THROUGH A BLAST WAVE. Glen W. Zumwalt and Homer H. Tang (Oklahoma State Univ., Stillwater. School of Mechanical Engineering). Feb. 1964. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 126p. Dep.(mn); $4.00(cy), 2(mn) OTS.

When a supersonic missile passes through a strong blast wave, such as that created by a nuclear explosion, the low pressure air trapped at the base of the missile acts as a cushion for the pressure rise. As the blast overpressure decays, a transient base pressure results which is an interaction of the instantaneous airstream conditions and the time-history of the jet mixing process at the base. The problem is thus divided into two parts: blast wave passage and post-passage transients. The relation of base pressure versus time was sought by analytical means. For the first part of the problem, a flow model was devised for the conditions before and after the blast front passage over a slender axisymmetric missile. A solution was obtained by a transformation to a wave-attached coordinate system. For the transient conditions following the blast front, a quasi-steady approach was adopted, using time iteration. To do so, it was necessary to extend Zumwalt's conical wake method for steady flow to include mass transfer from the airstream to the separated air at the base. A wind tunnel test program was designed and data analyzed to obtain empirical information required for effective conical jet pumping surface. These tests included both steady-state and transient base pressures. An analysis has resulted which is experimentally verified for simple base pressure transients, and which gives a prediction of base pressure-time history for head-on blast wave intersection with axisymmetric missiles. (auth)

8009 (TID-21338(p.146-67)) A PROGRAM TO CALCULATE THE ENERGY LOSS OF CHARGED PARTICLES PASSING THROUGH MATTER. D. A. Goldberg (Johns Hopkins Univ., Baltimore).

Both a description of the program, and a detailed set of instructions on the operational use of the program are included. A listing of the program and definitions of the symbols used, and a flow chart illustrating the logical operation of the program, are also included. (auth)

8010 (UCRL-7437) EQUATION OF STATE—A SURVEY OF THE THERMODYNAMIC PROPERTIES OF MATTER AT HIGH PRESSURES AND TEMPERATURES. Stephen G. Brush (California. Univ., Livermore. Lawrence Radiation Lab.). June 12, 1964. Contract W-7405-eng-48. 192p. Dep.(mn); $5.00(cy), 3(mn) OTS.

A review is presented of both theoretical calculations and experimental data for the low-density low-temperature, high-temperature low-density, and high-density low-temperature regions. Thermodynamic description of high-pressure states is also considered. (D.L.C.)

8011 (UCRL-7895(Rev.I)) STABILITY OF SPHERICAL GAS DETONATION. R. E. Duff and M. Finger (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 1964. Contract W-7405-eng-48. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In order to clarify the question of detonation stability, experiments were made on a spherically expanding wave in a low-pressure $C_2H_2-O_2$ mixture. The soot patterns obtained on glass witness plates are identical to those obtained by Shchelkin and Troshin in linear detonation systems in high-pressure H_2-O_2 mixtures. Thus, the intrinsic instability of a gaseous detonation wave is confirmed. (D.L.C.)

8012 (UCRL-11647) FORTRAN—SUBROUTINE RANGE: CALCULATING THE RANGE-ENERGY RELATION FOR CHARGED PARTICLES IN CHEMICAL ELEMENTS. W. Peter Trower (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 3, 1964. Contract W-7405-eng-48. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

FORTRAN subroutine RANGE calculates the differential energy loss and the range of charged particles, electrons and positrons excepted, with kinetic energies between 1 Mev and 500 Bev in any chemical element. With the results of the element calculations, the energy loss and range can be readily computed for chemical compounds and mixtures. (auth)

8013 (UCRL-Trans-1088(L)) GEOMETRICAL INFLUENCE ON THE TRANSVERSE MAGNETIC RESISTANCE EFFECT IN RECTANGULAR SEMICONDUCTOR PLATES. Hans-Joachim Lippmann and Friedrich Kuhrt. Translated by Margaret Little (Univ. of California, Livermore), from Z. Naturforsch., 13A: 462-74(1958). 41p. Dep.(mn); $4.60(fs), $1.43(mf) JCL.

The increase in resistance of an electron conductor in a transverse magnetic field has two causes: Decrease of the carrier mobility (physical resistance effect) and deflection of current streamlines (geometrical resistance effect). The geometry component of the resistance increase is computed by solving the boundary problems of a plate with current flowing through it in the transverse magnetic field. The method of conformal mapping leads to an integral expression for the resistance, which is derived for small and large Hall angles Θ. The geometrical influence on the resistance increase for small magnetic fields is a square function of Θ; but for large magnetic fields and finite aspect ratios of rectangular plates, the geometrical influence is always linear to tan Θ. The transition area between large and small Hall angles is obtained by numerical evaluation of the integral expression. For the special case of square plates, the field dependence of the resistance is described by a function valid for all values of Θ. (auth)

8014 (UCRL-Trans-1089(L)) CALCULATING THE FREQUENCY DEPENDENCE OF THE MAGNETIC RESISTANCE CHANGE. M. J. O. Strutt and F. K. von Willisen. Translated by Margaret Little (Univ. of California, Livermore), from Sci. Elec., 4: 153-72(1960). 28p. Dep. (mn); $2.60(fs), $1.04(mf) JCL.

In connection with the use of Group III-V semiconductor compounds in microwave technology, the change in resistance as dependent on frequency, caused by transverse magnetostatic fields, was studied for semiconductors with high carrier mobility. The goal is to provide a theory for the decrease of resistance change in samples of finite dimensions. For example, it was found with Corbino disks, in many cases, that a substantial decrease in the resistance change must be expected in the dm-wave region under certain conditions. This change is not explained by classical skin effect theory, but instead it depends on the carrier mobility in the semiconductor compound. It can be interpreted as a displacement of current streamlines, and is caused by the predominance of the additional term in Ohm's law, due to the influence of the magnetic field. This is shown to be a simple effect of the geometrical shape of the sample. (auth)

8015 (UCRL-Trans-1120(L)) THEORY OF THE PHOTOELECTRIC EFFECT IN METALS. A. Meessen. Translated by W. G. Robinson (Univ. of California, Lawrence Radiation Lab., Livermore), from J. Phys. Radium, 22: 308-20(May 1961). 59p. Dep.(mn); $5.60(fs), $1.97 (mf) JCL.

The photoelectric effect of metals is considered as a volume effect, determined by several processes. The penetration of light into the metal film is responsible for the inadequacy of measurements of the photoelectric efficiency Y per incident photon. It is preferable to refer to the efficiency Y_a per absorbed photon. The photoexcitation by oblique transitions determines the density and energy distribution of the excited electrons. A portion of excited electrons moves to the surface in a solid angle such that the velocity normal to the surface allows emission over the potential barrier. This rapidly varying factor actually determines the spectral distribution near the threshold. The individual or collective interactions of excited electrons with the other electrons, produce absorption or secondary emission of electrons. The experimental electron absorption length thus obtained for K shows that the theory of individual electron interactions needs to be improved. Y and Y_a can be calculated—with the real energy distribution of the excited electrons, assuming very thin films—or in the monokinetic approximation, considering the influence of light penetration, electron absorption, and film thickness. This method is very simple. The very large photoelectric efficiency of metals such as Be in the far ultraviolet is no more than the normal prolongation of the volume effect observable near the threshold. (auth)

8016 SMALL MAGNETOFLUID-DYNAMIC PERISTALTIC MOTIONS INSIDE AN ANNULAR CIRCULAR CYLINDRICAL INDUCTION COMPRESSOR. Joseph L. Neuringer and James H. Turner (Avco Corp., Wilmington, Mass.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2076-80(Dec. 1964).

The small magnetofluiddynamic peristaltic motions inside an annular circular cylindrical induction compressor are studied. The compressor consists of a circular cylindrical traveling wave tube of radius r_s on which is impressed a purely sinusoidal current sheet of the form $nI \exp i(kz-\omega t)\vec{\theta}$, where nI is the number of ampere turns per unit length, k the wave number, and ω the circular frequency. Inside the tube, an annulus $r_s \geq r \geq r_1$ is filled with a highly conducting fluid that is constrained at the ends not to move in the axial direction. The fluid to be pumped moves in an annulus $r_1 \geq r \geq r_2$ and is separated from the conducting fluid by an impermeable flexible diaphragm. The electromagnetically induced motions of these two inviscid and incompressible fluids, when the electromechanical coupling is weak, i.e., in the limit of small magnetic Reynolds number (based on wave speed and wavelength), are examined analytically. From the nature of the axial component of the body force induced in the constrained conducting fluid, it is shown that a time-averaged constant axial pressure gradient is induced which is transmitted to the pumped fluid by virtue of the mechanical coupling between them. If now, the induced, purely oscillatory, radial force component is sufficient to pinch and trap the pumped fluid, the ensuing motion of the latter would consist of trapped packets of fluid traveling in the wave direction with the wave speed of the diaphragm (equal to the speed of the traveling current sheet) against the pressure gradient induced in it. (auth)

8017 A THEORETICAL INVESTIGATION OF MHD CHANNEL ENTRANCE FLOWS. A. Maciulaitis and A. L. Loeffler, Jr. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2100-3(Dec. 1964).

A momentum-integral boundary-layer analysis is made of the entrance MHD flow of an incompressible electrically conducting fluid in a two-dimensional constant area channel. It is assumed that a uniform magnetic field perpendicular to the insulated channel walls exists in the channel. An electric field, perpendicular to both the magnetic field and mean flow, is permitted. The magnetic Reynolds number is assumed small. Closed-form solutions are obtained for both the laminar and turbulent cases. Variation of the freestream velocity in the flow direction is fully accounted for. Two cases are considered: the uniform velocity entry case, and the situation where the velocity profile at the channel entry plane is nonmagnetically fully developed. Agreement between the results and more exact numerical solutions for a few particular flow cases is excellent. Increasing the Hartmann number is shown to reduce entrance lengths appreciably, except in the very low Hartmann number range. Flows with nonmagnetically fully developed entry profiles, in general, require much larger entrance lengths than flows with a uniform entry profile. (auth)

8018 SONIC LINE OF MAGNETOHYDRODYNAMIC NOZZLE FLOW. Tatsuo Yamanaka (National Aerospace Lab., Tokyo). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2203-5(Dec. 1964).

It was found that the shape of the sonic line for the plane and axisymmetric nozzle flow of an infinitely conducting inviscid gas with a magnetic field everywhere parallel to the flow velocity is affected by a magnetic field intensity. If the Alfvén number is approaching infinity, i.e., a magnetic field intensity approaching zero, the shape of the sonic line becomes the same shape of an ordinary nonconducting gas. If the Alfvén number is less than 1, a parabola convex toward downstream changes into concave toward downstream. (C.E.S.)

8019 A GENERALIZATION OF THE PRINCIPLE OF DETAILED BALANCING IN μ-SPACE. E. C. G. Stueckelberg de Breidenbach. Helv. Phys. Acta, 37: 521-31(1964).

The H-theorem in μ-space for a mixture of free molecules or particles A, B, ... undergoing all sorts of multiple collisions or reactions (creation and annihilation) is generalized to the case, where detailed balancing (DB) does not hold, and for the 3 statistics (Boltzmann, Bose-Einstein, and Fermi-Dirac). The equilibrium condition is given in terms of the chemical potentials μ_A, μ_B, ... The transition probabilities between macrocells have to satisfy a weaker condition than DB. (auth)

8020 ABSORPTION OF ^{60}Co GAMMA-RAYS IN WATER AND SOURCE STRENGTH DETERMINATION OF A 6 CURIE ^{60}Co SOURCE BY A CHEMICAL METHOD. Knud Sehested, Ari Brynjolfsson, and Niels W. Holm (Atomenergikommissionen, Riso, Denmark). IVA (Ingeniorsvetenskapsakad.) Medd., No. 138, 13-20(1963).

Experiments were conducted on the validity of expressions for calculating the buildup factor for a ^{60}Co point source in water. The validity of the buildup function expressions was confirmed, and it was found that Fricke

dosimetry could be used to standardize ^{60}Co sources and to determine gamma absorption by water. (J.R.D.)

8021 MECHANICAL GENERATION OF ČERENKOV RADIATION IN A PERFECTLY CONDUCTING ELASTIC MEDIUM BORDERING ON VACUUM. [PART] I. S. Kaliski. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 618-28(1964). (In Russian)

Cherenkov radiation in a perfectly conducting elastic medium filling a vacuum-bounded half space is considered during the action of a moving force on the surface of the medium, for the case when the constant external magnetic field is perpendicular to the plane of motion. The cones of Cherenkov radiation are determined at supermagnetosonic and intermagnetosonic velocities. The radiation intensity is obtained, without taking dispersion into account. A stationary perturbation is shown to exist ahead of the fronts of the cones of propagation of the mechanical and electromagnetic perturbations, in the case of supermagnetosonic velocity. (auth)

8022 MECHANICAL GENERATION OF ČERENKOV RADIATION IN A PERFECTLY CONDUCTING ELASTIC MEDIUM BORDERING ON VACUUM. [PART] II. S. Kaliski. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 629-45(1964). (In Russian)

Cherenkov radiation in an elastic medium during the action of a moving force on the surface of the medium is considered for the case of anisotropic orientation of a constant external magnetic field. The general method of solution is similar to that used previously for an isotropically oriented field. The interaction field determining the fronts of cones of Cherenkov radiation was obtained, for supermagnetosonic and intermagnetosonic velocities. (M.J.T.)

8023 LIGHT SCATTERING BY A CHARGE MOVING IN A MEDIUM. A. Gailitis (Lebedev Inst. of Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 646-51(1964). (In Russian)

The scattering of a transverse electromagnetic wave by a single charge, moving through a transparent medium at velocities below and above that of light, is considered. Light scattering is shown to increase rapidly as the charge velocity approaches the velocity of light in the medium. At velocities above that of light, the scattering effect determines the spread of the Cherenkov radiation spectrum. (auth)

8024 ELECTRIC-FIELD GRADIENTS IN LIQUIDS BY DEUTERON QUADRUPOLE RELAXATION. G. Bonera and A. Rigamonti (Università, Pavia, Italy). J. Chem. Phys., 42: 175-80(Jan. 1, 1965).

The deuteron quadrupolar relaxation was studied for some liquids. As the spin-lattice quadrupole relaxation depends on the electric-field gradients (efg) at the nucleus the experimental values of T_1 were used in order to obtain the field gradients at the hydrogen site in the benzene and acetone molecules. For this purpose, the correlation times for the molecular motions responsible for the quadrupolar relaxation were estimated from proton magnetic relaxation measurements in mixtures of the liquid with its perdeuterated analog. A theoretical evaluation of the efg tensor was also performed by using MO's in the LCAO approximation with Slater's orthogonalized AO's. The agreement between the theoretical evaluation and the experimental results is more than satisfactory and it seems to confirm a certain validity of the wavefunctions and the method of calculation used. For chloroform a calculated efg tensor was used to obtain a value for the reorientational correlation time from the deuteron spin–lattice relaxation time. The results show the possibility of using proton and deuteron relaxation measurements to obtain reliable values for the quadrupole coupling constants in liquids. (auth)

8025 ANALYSIS OF THE EIGENSTATES OF Pr^{3+} IN $LaCl_3$ USING THE ZEEMAN EFFECT IN HIGH FIELDS. R. Sarup (Univ. of Holly Cross, Worcester, Mass. and Massachusetts Inst. of Tech., Cambridge) and M. H. Crozier. J. Chem. Phys., 42: 371-6(Jan. 1, 1965).

The Zeeman effect of the absorption and fluorescence spectra of Pr^{3+} in $LaCl_3$ was studied at liquid nitrogen and liquid helium temperatures in magnetic fields up to 69 kG. Both linear and quadratic effects were observed, and these were used to establish unequivocally the crystal quantum numbers of the observed energy levels. Crystal-field theory was used to calculate the magnetic behavior of the energy levels, and good agreement was found with experiment, but some systematic deviations were also noted. The second-order effect was found useful in understanding the nature of these deviations, and it appears that a crystal-field calculation fitted to the energy levels does not yield the eigenstates giving the best agreement with the observed behavior in high magnetic fields. (auth)

8026 KNOWLEDGE AND THE MEASUREMENT PROCESS. P. Benioff (Argonne National Lab., Ill.). Nuovo Cimento (10), 34: 1596-1617(Dec. 16, 1964).

An attempt is made to determine how the properties of the process of measurement limit the maximum attainable knowledge of the value of a measured quantity. The problem considered is whether both the scale pointer reading errors must approach zero and the number of observations approach infinity in order to know the exact value of a measured quantity or whether just the number of observations must approach infinity. After a preliminary discussion of the methods of treating experimental data and their relation to reading errors, the measurement of the width of a slit is discussed in some detail. A single measurement consists in placing an opaque sheet containing the slit on an array of detectors, illuminating the system with a strong source of light and counting the number of altered detectors. It is found that, at best, the uncertainty in the measured width of the slit is an interval equal to the width of the smallest detector used. Consequently in order to determine exactly a slit width at least the detector width must approach zero. It also turns out that under conditions often used for such measurements the number of observations must approach infinity. (auth)

8027 COLLISIONS OF THREE HARD SPHERES. Guido Sandri, Roger D. Sullivan, and Philip Norem (Aeronautical Research Associates, Princeton, N. J.). Phys. Rev. Letters, 13: 743-5(Dec. 21, 1964).

The orbits of three identical, classical, rigid, elastic spheres in otherwise empty flat Euclidean three-dimensional space were analyzed, and the phase-space domains, Γ_n, that correspond to the occurrence of n successive binary collisions were determined. The form of Γ_4 is illustrated, and a rigorous proof that Γ_5 is empty is described. The necessary and sufficient conditions for the occurrence of four collisions are given, and it is proved that five collisions are impossible. (C.E.S.)

8028 BROWNIAN MOTION IN SYSTEMS OF FINITE SIZE. Irwin Oppenheim and P. Mazur (Massachusetts Inst. of Tech., Cambridge and Universiteit, Leiden). Physica, 30: 1833-45(Oct. 1964).

The solution of the Langevin equation for a Brownian particle in an arbitrary field of force in a finite system (i.e. in the presence of walls) is related to the solution of the Langevin equation for an infinite system. Analytic expressions for correlation functions of the momentum in the absence of an external field are obtained. The importance of the order of the $V \to \infty$ and $t \to \infty$ limiting processes is discussed. (auth)

8029 A VARIATIONAL ACTION PRINCIPLE. M. C. Smith-Agreda (Cátedra de Física Matemática, Barcelona). Physica, 30: 1883-95(Oct. 1964).

An action principle for classical mechanics deduced from the variation of the transformation function in a formal Hilbert space that is the base for an operational development of classical mechanics is presented. This principle corresponds to the Schwinger's one of quantum mechanics. (auth)

8030 PRODUCTION OF POLARIZED ELECTRON BEAMS BY OPTICAL PUMPING. H. Boersch, J. Lem-

merich, and R. Schliepe (Technische Universität, Berlin). Z. Physik, 182: 166-70(1964). (In German)

The valence electrons in sodium vapor were aligned by optical pumping to a polarization between 5 and 15%. An electron beam of 10^{-12} amp, 10^{-2} Rad divergence and 1 mm diameter was obtained by ionization of the sodium vapor with uv light. This electron beam was polarized up to 2% as measured by Mott scattering. (auth)

8031 EFFECT OF THE MULTIPLICITY OF d(f) SHELLS ON ELECTRON INTERACTION IN CRYSTALS. S. V. Vonsovskii and M. S. Svirskii (Inst. of Physics of Metals, Academy of Sciences, USSR and Chelyabinsk State Pedagogical Inst., USSR). Zh. Eksperim. i Teor. Fiz., 47: 1354-66(Oct. 1964). (In Russian)

The exchange model is generalized by taking into account variation of multiplicity of the d or f shells induced by conductivity electrons. The Hamiltonian for direct exchange interaction of d electrons is generalized and the properties of the corresponding multiplicity excitation waves are discussed. The effect of changes of multiplicity on appearance of superconductivity and also on ordering of conductivity electron spins and d shell spins is considered within the framework of the generalized s–d exchange model. (auth)

8032 PRESSURE OF AN INTENSE PLANE WAVE ON A FREE CHARGE AND ON A CHARGE IN A MAGNETIC FIELD. V. S. Voronin and A. A. Kolomenskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1528-35(Oct. 1964). (In Russian)

A complete solution is obtained for the problem of motion of a charged particle in the field of a plane electromagnetic wave of arbitrary shape by taking into account radiation reactive forces. A general formula is derived for the pressure force of a wave on a particle for the case when the plane wave consists of a set of monochromatic waves of arbitrary frequency, polarization, and intensity. A particular case of the formula is the Thomson formula. A general formula is deduced for the pressure of a monochromatic plane wave on a charge produced in a magnetic field. The principle limit which radiation reaction imposes upon the mechanism of autoresonance acceleration is determined. (auth)

8033 GENERATION OF MICROWAVE HARMONICS IN IONIZED GASES. Clarence Burke Swan. Thesis, Toronto, Univ. of Toronto, 1963. 176p.

The generation of microwave harmonics in a low-pressure radio-frequency discharge is described. Continuous wave experiments at 2.9 gigacycles per second resulted in conversion efficiencies of 32 per cent, 13 per cent, and 6 per cent for the 2nd, 3rd, and 4th harmonics respectively. Measurements were made with fundamental power in the range 5 to 80 watts. It appears that the production of harmonics in the 2.9 gigacycles per second experiment is dependent on large electric field gradients in the discharge. This effect is analyzed for the simplified case of electrons in a cylindrical geometry with radial radio-frequency electric fields. As a first approximation, space charge effects are neglected and collisions are accounted for by a smeared-out damping force applied to the electrons. Results obtained with a digital computer show that the large electric field gradient in this model can produce high conversion efficiencies. It is expected that this is the important process in the more complex experimental configuration. An experiment is proposed in which many of the assumptions made in the analysis would be valid. This experiment would check the validity of the field gradient process. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8034 AN EXPERIMENTAL STUDY OF MAGNETOHYDRODYNAMIC FLOWS INDUCED BY APPLIED ELECTRIC AND MAGNETIC FIELDS. Robert Macormac Caddell. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 122p.

The type of motion induced in an originally static electrically conducting fluid subjected to a passage of current was studied and photographed. A solution of copper sulfate was chosen as the test fluid. Two basic models, identical in all aspects except for the manner by which the magnetic field intensity was produced, were employed. Each model was basically a straight tube containing a constriction in a plane perpendicular to the tube axis and midway between the ends of the tube. With the first model tested, the magnetic field intensity and the induced motion caused by electromagnetic effects depended solely on the flow of current through the fluid. Convective motion due to the thermal buoyancy completely masked out electromagnetic effects regardless of the physical orientation of the unit. The susceptibility of the test fluid to density changes in the presence of nonuniform heat generation appeared to be the principal cause of this strong convective effect. An alteration was made in the initial unit by locating a copper rod along the axis of the unit and insulating this rod from the fluid. Currents of several hundred amperes were passed through the rod to create a magnetic field concentric with the axis of the unit. Simultaneously, much lower currents were passed through the fluid. With this arrangement, convective effects still predominated when the axis of the unit was in a vertical plane. However, when this axis was rotated ninety degrees, the fluid patterns that resulted were of a decidedly different form. It appeared that in many cases the motion being observed was caused primarily by electromagnetic effects. Velocity measurements were obtained experimentally and compared with the analytical predictions developed from a solution by two other authors. A reasonable quantitative correlation was found. This provided added support to the notion that the observed fluid motion was caused principally by electromagnetic effects. (A.G.W.)

8035 EFFECT OF THRUSTOR ARCING ON ION ROCKET SYSTEM DESIGN. John B. Stover (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-682, 18p, $1.00. (CONF-640801-7)

From 4th Electric Propulsion Conference, Philadelphia.

Arcing between the electrodes of an ion rocket thrustor is investigated for the effect it has on the overall design of ion rocket systems. The effect of generator, transformer, and inserted impedances on system stability and efficiency, and on operating lifetime of thrustor components are considered. Rate of arcing, preferential arc paths, speed of arc interruption, and response of thrustors to voltage transients are also discussed. Results indicate that arcing is a system hazard and that arcing rates are of prime importance in the design and development of thrustors, thrustor arrays, and system components. Two system models for reducing the hazard are proposed. (auth)

8036 SOLID SURFACES. Proceedings of the International Conference of The Physics and Chemistry of Solid Surfaces, Brown University, Providence, Rhode Island, June 21-26, 1964. Harry C. Gatos, ed. Reprinted from Surface Sci., 2: 1-578(1964). Amsterdam, North-Holland Publishing Co., 1964. (CONF-640602)

Sixty-five papers presented at the International Conference on the Physics and Chemistry of Solid Surfaces are included under the following topics: surface states, electron and phonon transport at surfaces, atomic and molecular events at the solid-gas interface, surface thermodynamics and kinetics, electron emission and reflection, electrochemical properties of solid-liquid interface, and atomic structure of crystal surfaces. (M.C.G.)

8037 A THEORETICAL INVESTIGATION OF MHD CHANNEL ENTRANCE FLOWS. A. Maciulaitis and A. L. Loeffler, Jr. (Grumman Aircraft Engineering Corp., [Bethpage, N. Y.]). 22p. (CONF-416-5)

From American Physical Society Division of Fluid Dynamics, Cambridge, Mass., Nov. 1963.

A momentum-integral boundary layer analysis is made of the entrance MHD flow of an incompressible electrically conducting fluid in a two dimensional constant area channel. It is assumed that a uniform magnetic field

perpendicular to the insulated channel walls exists in the channel. An electric field, perpendicular to both the magnetic field and mean flow, is permitted. The magnetic Reynolds number is assumed small. Closed-form solutions are obtained for both the laminar and turbulent cases. Variation of the free stream velocity in the flow direction is fully accounted for. Two cases are considered: the uniform velocity entry case, and the situation where the velocity profile at the channel entry plane is nonmagnetically fully developed. Agreement between the results and more exact numerical solutions for a few particular flow cases is excellent. Increasing the Hartmann number is shown to appreciably reduce entrance lengths, except in the very low Hartmann number range. Flows with nonmagnetically fully developed entry profiles, in general, require much larger entrance lengths than flows with a uniform entry profile. (auth)

8038 ION OPTICS OF SASTRUGI ION ENGINES. S. L. Eilenberg, W. Seitz, and E. Caplinger (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-695, 50p, $1.00. (CONF-640801-16)

From 4th Electric Propulsion Conference, Philadelphia.

Criteria for the capability for evaluating ion engine electrode geometries are presented. A review of techniques used in electrode design are included along with results of ion optics studies. Emphasis is placed on the use of sastrugi configurations. (J.R.D.)

8039 ION AND ATOM ANGULAR DISTRIBUTIONS FROM A MULTI-BEAM CESIUM ION ENGINE. J. Perel, R. H. Vernon, and H. L. Daley (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-696, 29p, $1.00. (CONF-640801-15)

From 4th Electric Propulsion Conference, Philadelphia.

Beam probing experiments initiated to examine ion beam properties and the relations between beam phenomena and ion engine performance are described. Particular emphasis is given to the spatial mapping of particle efflux from a multibeam Cs ion engine. Ion and atom angular distributions were determined using a single scanning detector which is described together with its ion and atom detection modes of operation. The results are presented as angular distribution plots obtained under specific engine operating conditions. The results show the relations between beam properties and engine operational parameters. It was found that increasing the ion current increases beam width, but does not add significantly to the peak current density. The effect of the electrode configuration upon the atom angular distribution is presented. Although the beam properties examined are highly sensitive to variations in engine operational modes, the major difficulties were caused by the interrelation of the beam properties and the interaction of the probe with the beam. The data are applied to the limitations imposed on neutral fraction determinations using fixed position atom detectors. (auth)

8040 HIGH FREQUENCY ION SOURCE. Siegfried Klein (to Commissariat à l'Énergie Atomique). German Patent 1,179,309. Oct. 8, 1964. Priority date May 3, 1958, France.

The ion source comprises an evacuated tube of Pyrex glass or quartz provided with the means for feeding a substance to be ionized at one end. In the vicinity of its other end it has a transversely enlarged portion in the form of a flat bulb of small volume disposed transversely to the axis of the tube and located in the restricted zone of the concentrated electric field of a resonant cavity. (Gmelin Inst.)

Accelerators

8041 (UJV/1099/64) VÝPOČET A MĚŘENÍ VYSOKOFREKVENCNIHO URYCHLOVACÍHO SYSTÉMU CYKLOTRONU. (The Calculation and Measurement of the High-Frequency Acceleration System in a Cyclotron). T. Fukátko and J. Dobiáš (Ceskoslovenská Akademie Věd. Ústav Jaderného Výzkumu, Řež). [nd]. 17p. Dep.(mn).

The fundamental characteristic parameters of the high-frequency acceleration system of a cyclotron are calculated. The procedure for measuring the necessary quantities for tuning the dee circuit to the resonant frequency of the cyclotron is outlined. Calculations are carried out for the equivalent circuit of the dees; the length of the resonant link; the location of the connecting loop and the approximate length of the coaxial lead; the characteristic resonant frequencies of the dee circuit; the procedure for tuning the dee circuit to the resonant frequency; and the power delivered by the high-frequency generator to the accelerating system. The suitability of the described method for tuning the dee circuit to the resonant frequency of the cyclotron was confirmed on the cyclotron U-120 at the Institute for Nuclear Research. (TTT)

8042 ON THE NONLINEAR THEORY OF CHARGE DENSITY WAVES IN BEAMS WITH VARIABLE PARAMETERS. V. D. Shapiro (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 736-46(1964). (In Russian)

The nonlinear theory of parametric excitation of charge density waves in a density and velocity modulated beam is considered. The study is restricted to the simplest case of an infinitely wide and homogeneous beam with small modulation index. The oscillation amplitude and phase are shown to become periodic functions of the coordinate. The period of the amplitude oscillations and the minimum and maximum amplitude values are found. (auth)

8043 ANALYSIS OF THE PARTICLE DYNAMICS OF A CURVILINEAR ACCELERATOR. J. P. Ballad (English Electric Co., Ltd., Stafford, Eng.). J. Nucl. Energy, Pt. C, 6: 567-82(Nov.-Dec. 1964).

The curvilinear particle accelerator is analyzed for low-energy acceleration, in particular for the acceleration of deuterons from 2.4 to 21.6 Mev. The stability of the particle motion is investigated, and an estimate is made of the beam current. An order of magnitude calculation indicates a limiting current of 25 mamp in the pulse (average current ~1 mamp). The high beam current, together with the low-energy spread and end-extraction of the beam possessed by this accelerator, renders it an attractive rival to other low-energy machines. (auth)

8044 FIELDS PRODUCED BY A BEAM IN A WAVEGUIDE WITH RESISTIVE WALLS. J. van Bladel (Midwestern Universities Research Assn., Stoughton, Wis. and Univ. of Wisconsin, Madison). J. Nucl. Energy, Pt. C, 6: 583-90(Nov.-Dec. 1964).

The basic differential problem is set up for the fields produced by a periodic axial beam contained in a duct with resistive walls. The fundamental unknown is the axial component of the electric field. The solution is obtained as a power series in jZ/R_0, where Z is the surface impedance of the wall. Particular attention is given to beams in circular and rectangular waveguides. (auth)

8045 THE SOURCE OF POLARIZED PROTONS FOR THE MILAN CYCLOTRON. II. THE HOMOPOLAR GENERATOR. M. Castiglioni, A. Luccio, and C. Succi (Università, Milan and Istituto Nazionale di Fisica Nucleare, Milan). Nuovo Cimento (10), 34: 1781-9(Dec. 16, 1964). (In Italian)

A homopolar generator is described which supplies the current for the electromagnetic lens of the polarized atom source to be used with the Milan cyclotron. The generator has a bell-shaped rotor and liquid mercury brushes; it can deliver a current in excess of 6000 amp and a maximum voltage of 3 v. (auth)

8046 PHERMEX. Douglas Venable (Los Alamos Scientific Lab., N. Mex.). Phys. Today, 17: 19-22(Dec. 1964). (LA-DC-6523)

PHERMEX, a Pulsed High-Energy Radiographic Machine Emitting X Rays is a high-current standing-wave linear accelerator which generates intense bursts of x rays for flash radiographic studies of explosive-driven metal systems. A brief discussion is presented of the need for this

device and of some of its design features, operational parameters, and radiation output. Several radiographs are shown which illustrate typical applications to studies of fluid flow. (auth)

8047 MODES OF OSCILLATION OF A GROUNDED GRID CYCLOTRON OSCILLATOR. D. N. Basu Mallik (Saha Inst. of Nuclear Physics, Calcutta) and B. R. Nag. Radio Electron. Engr., 27: 27-36(Jan. 1964).

A linear analysis of a grounded-grid cyclotron oscillator considering the effect of all the important circuit elements is presented. It is shown that the oscillator may execute oscillations at one of the cyclotron-dee resonant frequencies and/or at one of the coupling transmission line frequencies. The conditions of excitation of these oscillations are derived. Experimental evidence obtained from a model oscillator verifying the above results are also given. (auth)

8048 RELAXATION PHENOMENA IN ELECTRON BEAMS. Kurt Ulmer and Bodo Zimmermann (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 182: 194-216 (1964). (In German)

In electron beams with high charge density anomalous shiftings and broadenings are observed as well as symmetrizations of the energy distribution. Former work, where these phenomena were ascribed to a relaxation process changing the energy distribution to a new equilibrium distribution, is continued. Quantitative expressions are derived for the energy spread and the shape of this new energy distribution. A relaxation degree is defined which measures the progress of relaxation. Measurements are described using the highest relaxation degrees yet reached. The shape of the measured energy distributions can be fitted to the derived shape with suitable choice of a single parameter. Peculiarities of measurements with superposed axial magnetic fields are discussed. (auth)

8049 THEORY OF ELECTRON CAPTURE IN THE BETATRON. A. N. Matveev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1550-1(Oct. 1964). (In Russian)

Azimuthal repulsion of injected electrons is considered. The effect of the repulsion in short injection pulses is noted. (auth)

8050 EXPERIMENTAL RESEARCH ON THE U-10 LINEAR ACCELERATOR. II. OPERATING CHARACTERISTICS. O. A. Valdner, A. A. Glazkov, E. G. Platnov, and V. D. Seleznev. p.108-24 of "Uskoriteli, No. 5." Moscow, Gosatomizdat, 1963.

In research on the operating characteristics of the U-10 accelerator, there is first an examination of energy spectra of particles in the U-10 which are taken with the aid of a magnetic analyzer. Experimental power curves are given for the U-10 for various operating conditions in relation to the input power (1.87, 1.53, 1.50, and 130 megawatts) and the average beam current (120 and 600 microamps). An analysis is given of the frequency characteristics of the U-10 which describe the relation between the energy of the electrons, half-width of the spectrum, and wave guide excitation frequency for various operating conditions of the U-10. Methods are described for experimental and graphical calculation of the following parameters: phase velocity distribution in the diaphragmed wave guide of the U-10; the relation between the width of the energy spectrum and the frequency. There is an examination of the power characteristics of the U-10. There is an analysis of a group of curves which illustrates the current characteristics of the U-10 which were obtained experimentally and by means of calculation. There is a graphical demonstration of the experimental relations between the load current and the width of the energy spectrum of the particles. It is shown that the average power of a beam of hard electrons in the U-10 may reach up to 700–900 watts. Experimental curves are given for the high-frequency efficiency of the U-10 in relation to the beam current and also the relations between the beam power, the high-frequency efficiency, and the frequency. The excellent accord of the experimental and calculated characteristics is pointed out as well as the reliability of the U-10 in conditions of prolonged use. (OTS)

8051 MEASUREMENT AND CORRECTION OF SOME PARAMETERS OF THE MAGNETIC FIELD OF A 30 Mev BETATRON. G. Geske. Thesis, Jena, Ger., Universität, 1963. 73p. $2.00(Gmelin, AED-DISS. 63-691). (In German)

The measurement of electron paths and field index in the 30 Mev betatron at Jena indicated the necessity of field corrections. The theory of electron motion of zero and higher order approximation is given. A method for direct determination of the position of the electron orbit was developed. Betatron operation experience is discussed. (Gmelin Inst.)

Astrophysics and Cosmology

Refer also to abstracts 8297 and 8332.

8052 (NYO-8924) COSMOGENIC RADIONUCLIDES IN STONE METEORITES (thesis). Philip J. Cressy, Jr. (Carnegie Inst. of Tech., Pittsburgh). June 1, 1964. Contract AT(30-1)-844. 135p. Dep.(mn); $4.00(cy), 3(mn) OTS.

A systematic study was made of variations in the specific activities of several cosmogenic radionuclides in stone meteorites. Samples of 13 stone meteorites were analyzed for cosmogenic ^{10}Be, ^{26}Al, ^{53}Mn, and ^{59}Ni activities; ^{36}Cl and ^{44}Ti analyses were made on several of these samples. Two of the samples were from recently-fallen meteorites; a number of short-lived radionuclides were studied in these in conjunction with other investigators at this laboratory. The experimental work included the separation and purification of chlorine, silicon, cobalt, titanium, manganese, nickel, aluminum, beryllium, calcium, and sodium; some were separated only in fresh falls. A teflon still was designed and constructed for the decomposition of stone meteorites and the separation of chlorine and silicon. An electroplating device was constructed for the electrodeposition of cobalt samples on copper cylinders for beta counting. A low-level Geiger counter system for counting fairly large beta-emitting samples was constructed, and a low-level gamma-gamma coincidence counting system was assembled. The specific activities of ^{10}Be, ^{26}Al, ^{53}Mn, and ^{59}Ni, including the results reported by other laboratories, were compared with each other, adopting ^{10}Be as a rough index of depth or shielding. The production of ^{53}Mn seems to go through a maximum with increasing depth (from about 0.25 to 0.55 dpm g^{-1} iron). The production of ^{59}Ni also goes through a maximum with depth (from 1 to 7 dpm g^{-1} nickel). These observations are qualitatively similar to the effects observed for these nuclides in iron meteorites, as observed by J. H. Kaye, although the magnitude of the ^{59}Ni maximum suggests appreciable neutron-capture contribution to this nuclide's production in stones. The ^{59}Ni production relative to ^{10}Be goes through a minimum at greater depths, and increases again to at least 4 dpm g^{-1} nickel, presumably as a result of neutron production at great depths. The ^{26}Al production appears to go through a slight maximum relative to ^{10}Be, although for the most part the ^{26}Al activities are remarkably constant between 0.2 and 0.3 dpm g^{-1} silicon while ^{10}Be is decreasing from 0.07 to 0.04 dpm g^{-1} oxygen. Comparison of ^{14}C activities in these samples with ^{10}Be also indicates an initial increase in ^{14}C production with increased shielding (from about 0.15 to 0.25 dpm ^{14}C g^{-1} oxygen). Rough estimates of the terrestrial age of Selma (about 7500 years) and the Admire stony-iron (about 9000 years) were obtained from comparisons of ^{10}Be, ^{14}C, and ^{53}Mn activities. An approximate cosmic-ray exposure age of 3.2×10^6 years was calculated for Kunashak, based on the apparent depletion in ^{10}Be specific activity. From this age and the observed ^{53}Mn activity, a half-life for ^{53}Mn of approximately 3×10^6 years was calculated, although this should more realistically be considered an upper limit. (auth)

8053 SOLAR RADIO EMISSION AS A CRITERION FOR SOLAR PROTON EVENT WARNING. J. D. Fletcher (North American Aviation, Inc., Downey, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2193-7(Dec. 1964).

The use of solar radio emission as an indication of impending proton arrival from a solar flare is discussed. Specific characteristics of solar radio emission on fixed frequencies were found to be associated with solar flares that are proton emitters. These signal characteristics are distinguishable from nonproton emitting flares. Fixed frequencies between 1000 and 3750 Mc tend to show recognizable signal characteristics that will give a warning time from a minimum of 30 min to an average of 2 hr before the arrival of protons near the earth. The correlation between solar radio emission and solar flares and between solar flares and solar cosmic ray or proton events was known for quite some time and is well established. If the knowledge were available that a particular solar flare was capable of producing protons, and that, within a relatively short period of time, the protons would be observed in the vicinity of the earth, the warning time gained would be used effectively in many ways. (auth)

8054 THE CHEMICAL COMPOSITION OF THE STARS. A. Unsoeld (Universität, Kiel). Angew. Chem. Intern. Ed. Engl., 3: 481-90(June 1964).

The evolution of stars and galactic systems is discussed, with emphasis on the nuclear processes involved and on stellar compositions at various evolutionary stages. (BBB)

8055 ON THE POSSIBILITY OF A GRAVITATIONAL ABERRATION. J. M. J. Kooy (Royal Military Academy, Breda, Netherlands and Technical Univ., Delft, Netherlands) and J. Berghuis. Astronaut. Acta, 10: 93-104(1964).

In the comparison of gravitation as an action-at-a-distance-force with the electromagnetic force, it seems probable that gravitation has the same fundamental character. Then it would be possible to conceive of gravitation as something propagating through space with the speed of light. The consequences of such a concept of gravitation are discussed, and the motion of a binary system of stars is studied. (auth)

8056 DETECTION OF AN INTERSTELLAR FLUX OF GAMMA-RAYS. Albert E. Metzger (California Inst. of Tech., Pasadena), Ernest C. Anderson, Marvin A. Van Dilla, and James R. Arnold. Nature, 204: 766-7(Nov. 21, 1964). (LA-DC-6648)

Gamma radiation measurements in space at 7×10^4 km to 4×10^5 km from the earth are reported and analyzed. Evidence that the gamma flux is of interstellar origin is presented. It is noted that the flux is apparently not of synchrotron origin nor the result of high-energy particle interactions. The production mechanisms of bremsstrahlung and inverse Compton scattering are more likely. (J.R.D.)

8057 ON INTERGALACTIC GAS AS A POSSIBLE ABSORBER OF EXTRAGALACTIC RADIO NOISE. D. W. Sciama (Cambridge Univ., Mass.). Nature, 204: 767-8 (Nov. 21, 1964).

An explanation concerning the origin of and radio noise absorption by background radiation at low frequencies (<10 Mc/s) is presented. Most of this radiation is assumed to be from extragalactic space filled with ionized hydrogen of electron density of 10^{-5} to 10^{-4} g/cm^{-3} at about $10^{4\circ}$K. Under these conditions the emission of the gas out to a Hubble radius lies in the range 0.3 to 30 cm^{-6} pc. Since most of the extragalactic radiation has a path-length of about a Hubble radius, the intergalactic gas might be responsible for the absorption. (J.R.D.)

8058 NEUTRINO-SPECTROSCOPY OF THE SOLAR INTERIOR. J. N. Bahcall (California Inst. of Tech., Pasadena). Phys. Letters, 13: 332-3(Dec. 15, 1964).

Theoretical results concerning the neutrino absorbers T, ^{7}Li, ^{11}B, and ^{87}Rb are presented. The absorbers T and ^{87}Rb can detect primarily the low-energy solar neutrinos, and ^{7}Li and ^{11}B are primarily sensitive to the ^{8}B neutrinos. The absorbers ^{7}Li and ^{11}B can be used to establish the direction of the neutrino source by observing the direction in which the created electrons are produced. (C.E.S.)

8059 ON THE TIME-SCALE AND THE REDSHIFT VERSUS MAGNITUDE AND METRIC ANGULAR DIAMETER RELATIONS IN SOME STEADY-STATE LIKE UNIVERSE. Hidekazu Nariai (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 32: 647-67(Oct. 1964).

An investigation of the time-scale and the redshift-magnitude relation for some steady-state like model universe in Hoyle's cosmology is carried out on the assumption that the absolute total luminosity L of a standard galaxy is changing with the lapse of time at a definite rate. It is revealed that the L has only to decrease rather slowly for the purpose of reconciling both the time-scale and the redshift-magnitude relation with their empirical ones. An attempt is made to investigate to what extent the monotonously decreasing nature of the metric angular diameter θ_0 (as a function of the redshift z) for a standard cluster of galaxies can be modified by the resignation of the usual assumption that its linear diameter is constant in time. (auth)

8060 THE SOLAR WIND AND THE INTERPLANETARY MAGNETIC FIELD. James Lequeux (Faculte des Sciences, Paris). Sci. Progr.-Nature, No. 3354, 369-75 (Oct. 1964). (In French)

The source of the solar winds and the effects of the interplanetary magnetic field on it are described. The interaction of the solar wind with the earth and with the moon is discussed. The extent of the solar wind and the possibility of other stars having coronas and winds are considered. (J.S.R.)

8061 SINTON BANDS: EVIDENCE FOR DEUTERATED WATER ON MARS. James S. Shirk, William A. Haseltine, and George C. Pimentel (Univ. of California, Berkeley). Science, 147: 48-9(Jan. 1, 1965).

It is speculated that the infrared absorption bands previously observed by Sinton at 2710, 2793, and 2898 cm^{-1}, in the spectrum of Mars, may be due to gaseous D_2O and HDO in the Martian atmosphere. The implication would be that the deuterium : hydrogen ratio exceeds that on Earth, presumably because of escape of the lighter gases from Mars, with accompanying gravitational fractionation of the hydrogen isotopes. (auth)

8062 STRUCTURE AND STABILITY OF STELLAR SHOCKS. Angelo James Skalafuris. Thesis, Waltham, Mass., Brandeis Univ., 1963. 233p.

The detailed structure of a radiating shock wave moving in a stellar atmosphere is investigated. The analysis consists of two parts: a stability analysis that discusses the fundamental conditions of existence, and a microscopic study of the gas with its radiation field. Physically, this is a study of a radiating shock wave in a warm hydrogen gas. The unique feature of this model is the optical transparency of the shock, which permits the radiation field to couple the gas on both sides of the shock. The first chapter is an introduction to observational evidence that has led to this particular model, and a review of the literature in the field. The second chapter consists of a qualitative analysis of the phenomenon and establishes the physical basis of the model. Chapter three initiates the microscopic studies starting from the region in front of the shock wave where photoelectric pre-ionization occurs. The fourth chapter presents a solution to the classical problem of the stability of a weak radiating shock wave moving in a gravitational field in the presence of pressure and density gradients. Chapter five is an analysis of the kinetics immediately behind the shock discontinuity. Inelastic collisions, atom proton and electron temperatures are examined. In the sixth chapter, the origin of the radiation field is analyzed, and its effects upon previous results are examined. The stress of each chapter is on the basic physical processes which occur in each region. The absence of experimental methods in this astrophysical problem required analytical experi-

ments. The problem was formulated accurately on the IBM 7040 in order to index the physical processes in order of importance and to establish the regions where any one process was dominant. Numerical results only sufficient to establish and illustrate the physics of the system are presented. The methods of solution are discussed in sufficient detail so that applications can be made to stars other than the classical models considered here. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8063 LECTURES ON ASTROPHYSICS AND WEAK INTERACTIONS. Vol. 2 of the 1963 Brandeis Summer Institute Lectures on Theoretical Physics. S. Hayakawa, H.-Y. Chiu, G. Feinberg, and M. Dresden. Waltham, Mass., Brandeis University, 1963. 476p. $4.00

Four lectures are presented on the origin of cosmic rays, neutrino astrophysics, theory of weak interactions at high energy, and the existence and significance of parastatistics. Separate abstracts have been prepared for each. (L.B.S.)

For abstracts of individual lectures see: 8064, 8128, 8243, and 8313.

8064 NEUTRINO ASTROPHYSICS. Hong-Yee Chiu (NASA Inst. for Space Studies and Columbia Univ.). p.165-275 of "Lectures on Astrophysics and Weak Interactions. Vol. 2." Waltham, Mass., Brandeis University, 1963.

The general field of astrophysics is surveyed with discussions on the general properties of a star, equations of stellar structure, nuclear reactions, and the Hertzsprung-Russell diagram. Neutrino astrophysics is then treated, with discussions on neutrino processes, general relativity, neutron stars and cosmology. (L.B.S.)

Atomic Physics

Refer also to abstract 8394.

8065 (NYO-10586) X-RAY WAVELENGTHS. Final Report. J. A. Bearden (Johns Hopkins Univ., Baltimore). 1964. Contract AT(30-1)-2543. 548p. Dep.; $8.45(cy), 9(mn) OTS.

Wavelengths of the K, L, M,... x-ray lines and x-ray absorption edges, as well as other data pertinent to the x-ray emission and absorption, are tabulated for the elements. Wavelength standards are evaluated. (T.F.H.)

8066 (UCRL-11135) SEMICLASSICAL ANALYSIS OF WEAKLY INELASTIC MOLECULAR COLLISIONS. M. Child (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1963. Contract W-7405-eng-48. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Semiclassical analysis is applied to vibrationally and rotationally inelastic molecular collisions. The deflection angles for weak transitions are shown to be simply related to the classical deflection angles for elastic scattering conditions. The position of the crossing-point, at which the values of the initial and final Lagrangian are equal, plays an important role in the discussion. Expressions are derived for these points for different types of transition. Allowance is made for the fact that the effective translational potential energy may depend on the vibrational states of the members of the system. (auth)

8067 (UCRL-12136) L- AND M-SHELL IONIZATION CROSS SECTION FOR Nd, Sm, Gd, Tb, Dy, AND Ho USING 0.5- TO 1.7-Mev PROTONS. R. D. Worley, D. L. Potter, and J. M. Khan (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 26, 1964. Contract W-7405-eng-48. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

L- and M-shell thick-target yields are measured for Nd, Sm, Gd, Tb, Dy, and Ho, employing protons with energies between 0.5 and 1.7 Mev. The respective ionization cross sections are calculated from these values. The L-shell ionization cross section is compared with Born approximation theory, and found to be within the experimental error. The experimental values of the cross section range between 0.8 and 5.6 ($\times 10^{-20}$ cm^2/atom) for the M-shell and between 0.3 and 3.1 ($\times 10^{-22}$ cm^2/atom) for the L-shell. (auth)

8068 (UCRL-Trans-1109(Rev.)) EFFECT OF RADIATIVE TRANSITIONS ON THE DIFFUSION OF A HYDROGEN ATOM AMONG ENERGETIC LEVELS. E. I. Karpushkina and D. P. Grechukhin [U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoĭ Energii]. Translated by Robert Pyle (Univ. of California, Lawrence Radiation Lab., Berkeley), from Russian Preprint. [1963]. 55p. Dep.(mn); $3.00(cy), 1(mn) OTS; $5.60(fs), $1.37(mf) JCL.

The role of radiative transitions is clarified, in the diffusion of a hydrogen atom between energy levels. The analysis is made with the calculation of radiative transitions of the hydrogen atom included. The influence of the Stark effect on the path of diffusion is not analyzed. (auth)

8069 THE TIME OF FLIGHT METHOD FOR MEASURING THE RANGE-ENERGY RELATION FOR He IONS IN ALUMINUM AT 18 TO 38 Mev. N. I. Venikov and N. I. Chumakov. At. Energ. (USSR), 17: 503-4(Dec. 1964). (In Russian)

A 1.5-m cyclotron and a multichannel analyzer were used in measuring the range-energy relation for 18- to 38-Mev He ions in Al. Nearly 10% of the ion beam, deflected by a sector magnet, was captured by a graphite target; the rest was captured by a graphite lattice at 5515 mm from the target. The time analyzer recorded γ quanta on the target and the lattice. The order of error in ion energy measurements did not exceed ±0.4%. A stack of foils was used for determining ion tracks. The range-energy data are in agreement with those published previously. (R.V.J.)

8070 RECHARGE OF 2 TO 13.3 Mev OXYGEN IONS ON THIN ALUNDUM FILMS. N. I. Venikov, N. I. Chumakov, and B. I. Khoroshavin. At. Energ. (USSR), 17: 504-5 (Dec. 1964). (In Russian)

The concentrations of ions with various charges as a function of stripped beam energy were studied using a cyclotron that accelerated $^{16}O^{2+}$ ions at the third, fifth, and seventh high-frequency subharmonics. The emitted beam charge was analyzed after passage through ~ 20mg/cm^2 alundum film. The curves of charge concentrations are given. (R.V.J.)

8071 COLLISIONS OF LONG-LIVED EXCITED IONS OF OXYGEN AND NITROGEN. William McGowan and Larkin Kerwin (Université Laval, Quebec). Can. J. Phys., 42: 2086-2101(Nov. 1964).

The role of some excited ions in laboratory ion–molecule reactions was investigated, and their possible importance in the upper atmosphere considered. The mass spectrometer techniques of Aston banding and of comparing ionization probability curves of parent and product ions were applied to studies of collision-induced dissociation and charge exchange of oxygen and nitrogen in their parent gas. In every case studied, cross sections depended markedly upon the presence in the ion beam of ions in metastable or long-lived radiative states. In order that an ion reach the collision region, it had to have a mean lifetime greater than 3 μsec. The a $^4\Pi_u$ and b $^4\Sigma_g^-$ excited states of O_2^+ were identified in the collision $O_2^{+\prime}$ coll $O_2 \rightarrow O^+ + O + O_2$. Higher states of O_2^+, which have not as yet been identified spectroscopically, were found in the collision $O_2^{+\prime}$ coll $O_2 \rightarrow O^+ + O^- + O_2^+$. The thresholds of these new states are 23.9, 27.9, 31.3, and 34.1 ev with an uncertainty ±0.2 ev. From the collision-induced dissociation of N_2^+, the A $^2\Pi_u$ and the $^4\Sigma_u^+$ states were identified. Also, the reported transfer of the v = 3 level of the B $^2\Sigma_u^+$ to the v = 14 level of the A $^2\Pi_u$ was found. The cross section for 10/01 charged exchange of N_2^+ in N_2 exhibited a marked decrease as excited-state ions diluted the beam. The 10/01 collisions of N^+ in N_2 and O^+ in O_2 exhibited an increase in cross section as metastables were added to the parent ion beam. The 10/20 reaction of O_2^+ in O_2 was also observed to depend on excited O_2^+ ions. (auth)

8072 EFFECT OF ELECTRONIC SPACE CHARGES ON THE IONIZATION PROBABILITY CURVES OF GAS. P. Marmet (Université Laval, Quebec). Can. J. Phys., 42: 2102-20(Nov. 1964). (In French)

In electron impact studies, the difference between the ideal ionization probability curve which would be obtained with monoenergetic electrons and the experimental curve produced with a certain energy distribution is usually interpreted using the Maxwellian distribution of thermally emitted electrons and assuming that the electronic space charge and accelerating potential do not modify the energy distribution. Several recent papers mention contrarily that there is a redistribution of energy after a relaxation time. It will be shown that the influence of this redistribution of energy on ionization efficiency curves is different for different ion sources. It devolves that several instrumental effects can be explained, and that the electron energy distribution cannot be simply deduced from the sharpness of the discontinuities in the ionization efficiency curve. (auth)

8073 REACTIVE SCATTERING IN MOLECULAR BEAMS: EVIDENCE FOR A STRIPPING MECHANISM IN REACTIONS OF ALKALI ATOMS WITH HALOGENS. K. R. Wilson (Univ. of California, Berkeley), G. H. Kewi, J. A. Norris, R. R. Herm, J. H. Birely, and D. R. Herschbach. J. Chem. Phys., 41: 1154-6(Aug. 15, 1964). (UCRL-11534)

Crossed-beam studies were made of the reactions of K, Rb, and Cs atoms with Br_2, I_2, ICl, and IBr. It was found that, for all these systems, the reaction cross sections are remarkably large, $\gtrsim 100$ Å^2, much of the alkali halide product recoils forward with respect to the incident alkali-atom beam, and most of the chemical energy released appears as vibrational excitation of the alkali halide. These properties suggest a stripping mechanism of the type familiar in nuclear physics, in contrast to the rebound mechanism which was found in a previous study of the reactions of alkali atoms with alkyl iodides. (C.E.S.)

8074 DEPENDENCE OF THE PROBABILITIES OF VIBRATIONAL DE-EXCITATION ON INTERACTION POTENTIALS. Hyung Kyu Shin (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys., 42: 59-62(Jan. 1, 1965).

Using the WKB semiclassical approximation, the dependence of the probability of vibrational de-excitation on the assumed form of the interaction potential is discussed. The asymptotic results show that the Morse and Lennard-Jones potentials have, respectively, two and three correction terms in the exponential part. The magnitudes of the correction terms are important compared to the leading term. The exact form of the leading term is also dependent upon the interaction potential. (auth)

8075 ELECTRON SPIN RESONANCE OF IRRADIATED QUARTZ: ATOMIC HYDROGEN. R. A. Weeks and M. Abraham (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 42: 68-71(Jan. 1, 1965). (ORNL-P-263)

An electron spin resonance spectrum observed in irradiated synthetic quartz crystals is attributed to atomic hydrogen in interstitial sites. The quartz specimens were irradiated with 1.7 Mev electrons at ~300°K (10^{18} electrons cm^{-2}) and then with ^{60}Co γ rays (~10^7 R) at ~80°K and measurements were made without warming. The hydrogen spectra had a hyperfine constant A = 521.3 Oe (1453.1 Mc/sec) when the applied field was along the crystal threefold axis. An anisotropy of the hyperfine interaction of the order of 0.75 Oe was detected. The g value was 2.0021 ± 0.0005 and evidence for a small variation in this value with rotation was inferred. There are three sites for the atomic hydrogen in the unit cell that are related by the three fold symmetry operator of the crystal and that are otherwise equivalent. Additional hyperfine interactions with ^{29}Si nuclei were also observed enabling a tentative model of the sites to be proposed. The width of the line was 0.1 Oe and was attributed mainly to field inhomogeneity. Another spectrum was observed with a slightly smaller hyperfine interaction and was also attributed to atomic hydrogen in a different interstitial site. Detailed measurements were not made due to the low intensity of the spectrum. (auth)

8076 SLOW-NEUTRON INELASTIC SCATTERING FROM LOW-TEMPERATURE GASEOUS METHANE, LIQUID METHANE, AND SOLID METHANE. Y. D. Harker and R. M. Brugger (Philips Petroleum Co., Idaho Falls, Idaho). J. Chem. Phys., 42: 275-84(Jan. 1, 1965).

The partial differential cross sections for inelastic scattering of neutrons from samples of cold gaseous (T = 125°K), methane (T = 99°K), and solid methane (T = 83°K) were measured with the materials testing reactor (MTR) phased chopper velocity selector. The results were compared to the theory reported by Griffing for methane gas, which fits the cold-gas data very well over the entire range of the experiment and also fits the liquid and solid data at the large momentum transfers. The results of these comparisons indicate that the rotations are free in all three phases and that, in the liquid and solid phases, there are oscillations of the center of mass of the molecule with dominant transitions having an energy change near 0.017 ev. The range of agreement of the gas theory with the liquid and solid data indicates that the liquid and solid act according to the gas model out to a time of roughly 5×10^{-13} sec. The similarity of the liquid and solid data over the range of the experiment suggest further that they act similarly out to even longer times. The zeroth and first moments of energy transfer were calculated and for the gas compare favorably with a molecular theory that treats the rotations classically. For the liquid and solid data, the moments give further indications of the molecular oscillations. (auth)

8077 FRANCK-CONDON FACTORS FOR THE IONIZATION OF H_2, HD, AND D_2. Morton E. Wacks. J. Res. Natl. Bur. Std., 68A: 631-3(Nov.-Dec. 1964).

Franck-Condon factors for the following ionization transitions were computed assuming a Morse potential: $H_2\ X^1\Sigma_g^+(v = 0) \rightarrow H_2^+\ X^2\Sigma_g^+(v = 0 \rightarrow 15)$, HD $X^1\Sigma^+(v = 0) \rightarrow$ $HD^+\ X^2\Sigma^+(v = 0 \rightarrow 15)$, and $D_2\ X^1\Sigma_g^+(v = 0) \rightarrow D_2^+\ X^2\Sigma_g^+$ $(v = 0 \rightarrow 15)$. The results are used to interpret several recent ionization experiments which used essentially a monoenergetic ionizing medium. The relative importance of autoionization and direct ionization excitation processes are discussed. (auth)

8078 ON THE UTILIZATION OF NEGATIVE PARAMETERS IN THE CALCULATION OF THE ENERGY OPERATOR MATRIX ELEMENTS FOR ONE ELECTRON OUTSIDE THE OPEN SHELL. A. Savukynas, E. Naslenas, and A. Jucys (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 299-310(1964). (In Russian)

The electron configuration $l_0^q l$ with fixed l_0 and arbitrary l is considered. The phase relations between the coefficients of the radial integrals under the substitution $l \rightarrow -l-1$ were found. The method of application of these relations is demonstrated with actual examples. (auth)

8079 ON THE CALCULATION OF THE ENERGY SPECTRUM OF ATOMS HAVING CONFIGURATIONS dl AND d^9l. J. Vizbaraite, A. Savukynas, and A. Jucys (Kapsukas State Univ., Vilnius, USSR and Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 311-30(1964). (In Russian)

The expressions for the coefficients of the radial integrals in the formulas of the energy operator matrix elements for the electronic configurations dl and d^9l in terms of quantum number l are given. The three vector coupling schemes LS, LS_0, and J_0l are considered. For the configurations $3d^94f$ and $3d^95g$ of Cu^+ the coupling scheme J_0l is applied. (auth)

8080 ON A NUMERICAL CALCULATION OF THE HARTREE-FOCK DIAGRAMS IN THE FIRST AND SECOND ORDERS OF THE FIELD FORMULATION OF PERTURBATION THEORY FOR GROUND STATE ENERGY OF LIGHT

ATOMS. A. Matulis, U. Safronova, and V. Tolmatshov (Karpov Inst. of Physics and Chemistry, Moscow and Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 331-46(1964).

The Hartree-Fock diagrams for ground state energies in the first and second orders of the field formulation of perturbation theory are numerically studied. In this connection the Feynmann diagrammatic techniques for nondegenerated levels are applied for nondegenerated and some degenerated levels. The ground state energies for atoms from He to Ne are calculated and comparison with experiment is given. (auth)

8081 ON THE RESONANCE ANNIHILATION OF POSITRONS IN COLLISIONS WITH NEUTRAL ATOMS OR MOLECULES. V. I. Goldanskii and Yu. S. Sayasov (Inst. of Chemical Physics, Moscow). Phys. Letters, 13: 300-1 (Dec. 15, 1964).

The cross sections of positron annihilation in collisions with different neutral atoms or molecules were previously found to be 10 to 1000 times as large as the cross sections determined by the Dirac formula. A qualitative and quantitative interpretation of this phenomenon is presented. It is supposed that it is possible for a positron to form with a scattering particle, a bound state (which may also be a virtual one) with a binding energy sufficiently close to zero. (C.E.S.)

8082 EFFECT OF AN EXTERNAL ELECTRIC FIELD ON INNER ELECTRON SHELLS IN URANIUM OBSERVED BY MEANS OF INTERNAL CONVERSION. T. Novakov and J. M. Hollander (Univ. of California, Berkeley). Phys. Letters, 13: 301-3(Dec. 15, 1964).

Experiments are performed in order to establish if measurable changes in inner electron shells can be induced by external electric fields of the order of 10^6 to 10^7 v/cm. The idea was to expose radioactive sources that emit internal conversion electrons to high electric fields and to observe the internal conversion lines with a high resolution beta spectrometer. The characteristics of the observed effect strongly resemble the Stark effect. However, the energy shifts are relatively so big that the external field would be unable to produce them directly. It is proposed that perhaps an internal atomic or molecular mechanism amplifies the external field. (C.E.S.)

8083 POLARISATION (NEAR THRESHOLD) OF THE SPECTRAL LINES λ = 5791/90 Å λ = 5770 Å OF MERCURY, EXCITED BY ELECTRON IMPACT. H. G. M. Heideman (Rijksuniversiteit, Utrecht). Phys. Letters, 13: 309-10(Dec. 15, 1964).

Excitation and polarization curves of the spectral lines λ = 5791/90 and 5770 Å of mercury excited by electron impact at 9 to 20 ev are presented. The mercury vapor pressure was 10^{-3} torr, and the beam current was 13 μamp. There were no indications that the polarization tends to zero at threshold as previously suggested. (C.E.S.)

8084 ON THE RELATION BETWEEN THE FORM-FACTOR RATIO IN $K_{\mu 3}$ DECAY AND THE SCALAR COUPLING CONSTANT IN μ CAPTURE. J. J. J. Kokkedee and M. Veltman (CERN, Geneva). Phys. Letters, 13: 340-1(Dec. 15, 1964).

The magnitude of the form factor ratio ξ for meson ($K_{\mu 3}$) decay is considered. A relation between ξ and the scalar coupling constant ξ' in the nucleonic current in meson (μ) capture is derived. In the framework of the eightfold way any exchanged system giving rise to ξ' in μ capture has a partner in an octet which may contribute to ξ in $K_{\mu 3}$ decay. A model is introduced to obtain an approximate relation between the two parameters. The model is based on the assumption that the main contributions to ξ and ξ' arise from the exchange of scalar mesons K' and π', respectively, which are assumed to be members of the same octet. K' is identified with the κ (725) resonance. (C.E.S.)

8085 PRODUCTION OF METASTABLE HYDROGEN ATOMS IN PROTON-RARE-GAS COLLISIONS. D. Jaecks, B. Van Zyl, and R. Geballe (Univ. of Washington, Seattle). Phys. Rev., 137: A340-6(Jan. 18, 1965).

Cross sections for electron capture into the metastable hydrogen 2s level for proton–rare-gas collisions were measured. The 2s state population is determined by applying an electric field in the reaction region, leading to a mixing of the $2s_{\frac{1}{2}}$ and the $2p_{\frac{1}{2}}$ atomic substates. The increase in the detected Lyman-alpha signal over that observed in the field-free case is related to the ratio of the cross sections for capture into the 2s and the 2p states. The cross sections, measured for proton energies between 1.5 and 23 kev, exhibit structure similar to that observed in 2p-state capture. Possible interpretations of the results are discussed. (auth)

8086 EFFECT OF HIGH-INTENSITY MICROWAVE RADIATION ON OPTICAL TRANSITIONS OF ATOMIC HYDROGEN. Oldwig von Roos (California Inst. of Tech., Pasadena). Phys. Rev., 137: A358-60(Jan. 18, 1965).

It is shown that the interaction of atomic systems with high-intensity microwave radiation leads to characteristic splittings of optical spectral lines. In particular, if the frequency of the microwave radiation is in resonance with sublevel spacings of the atomic system, optical lines will exhibit a multiplet structure which depends in a simple way on the intensity and frequency of the microwave radiation. Detailed calculations are performed for the simplest atomic system, i.e., atomic hydrogen. (auth)

8087 POPULATION DISTRIBUTIONS IN CHARGE EXCHANGE. I. PROTON CAPTURE CROSS SECTIONS FOR LEVELS n = 1 THROUGH n = 15. John R. Hiskes (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Phys. Rev., 137: A361-4(Jan. 18, 1965). (CLM-P-43)

The charge-exchange capture cross sections are calculated for captures into all states of the hydrogen atom for levels through n = 15, using the Brinkman-Kramers matrix element. These expressions are sufficiently general to simulate captures from all the elements, assuming only one electron is active. (auth)

8088 GENERALIZATION OF THE "LINEAR THEORY" OF CONFIGURATION INTERACTION. B. G. Wybourne (Argonne National Lab., Ill.). Phys. Rev., 137: A364-8(Jan. 18, 1965).

The linear theory of configuration interaction succeeds well in giving a phenomenological description of the energy levels of equivalent-electron systems. The generalization of the linear theory to configurations containing nonequivalent electrons is examined from the point of view of second-order perturbation theory. It is shown that most second-order electrostatic interactions can be phenomenologically described by the first-order terms of a set of effective two-body scalar interactions. The significance of these interactions in atomic energy-level calculations is considered. (auth)

8089 FINE STRUCTURE CONSTANTS OF METASTABLE H_2 IN THE $c\,^3\Pi_u$ STATE. Lue-Yung Chow Chiu (Univ. of Chicago). Phys. Rev., 137: A384-7(Jan. 18, 1965).

The expectation values of spin-orbit (A_1) spin-other-orbit (A_2) and spin-spin (B_0 and B_2) interactions were evaluated over the electronic wave function for the $c^3\Pi_u$ state of H_2. A_1 = 5.737, A_2 = –9.8, B_0 = 1.33, and B_2 = –3.84 kMc. These values agree well with those obtained from Lichten's experimental fine-structure splittings. The electronic wave function used is a linear combination of Heitler-London-type and ionic-type wave functions. By expressing the gradient operators as components of a spherical tensor, the spin-other-orbit interaction can be expressed as a linear combination of irregular solid spherical harmonics of the first order, while the space part of the spin-spin interaction consists of irregular solid spherical harmonics of the second order. The method of expansion and evaluation of these irregular solid spherical harmonics for a two-electron system is discussed in detail. The small second-order perturbations due to the nearby rotational states are also calculated. (auth)

8090 ELECTRON EXCITATION CROSS SECTION OF THE $3^2S \rightarrow 3^2P$ TRANSITION OF SODIUM. Larry L. Barnes, Neal F. Lane, and Chun C. Lin (Univ. of Oklahoma, Norman). Phys. Rev., 137: A388-91(Jan. 18, 1965).

The cross section of the $3^2S \rightarrow 3^2P$ transition of sodium produced by electron impact was calculated by numerical integration of the set of three-channel differential equations. With the use of this numerical procedure, it is no longer necessary to replace the nondiagonal matrix elements of the interaction potential by their asymptotic forms and to neglect the diagonal part of the interaction-potential matrix, as was done in previous calculations. The cross sections calculated by this numerical scheme are smaller than those of previous work, and the difference can be ascribed to the use of the true interaction potentials rather than their asymptotic forms. An outline of the general formulation of the numerical method for an n-channel case is given. (auth)

8091 NEUTRON DIFFRACTION STUDY OF TEMPERATURE-DEPENDENT PROPERTIES OF PALLADIUM CONTAINING ABSORBED HYDROGEN. G. A. Ferguson, Jr. (Catholic Univ. of America, Washington, D. C. and Naval Research Lab., Washington, D. C.), A. I. Schindler, T. Tanaka, and T. Morita. Phys. Rev., 137: A483-7 (Jan. 18, 1965).

Neutron diffraction techniques were used to study the hydrogen-atom configuration in a single-phase sample of beta-PdH at several selected temperatures. The suggested low-temperature ($T \ll 55°K$) structure of this compound is one which conforms to the space group $R\bar{3}m$, which differs from the high temperature ($T \gg 55°K$) structure [$Fm\bar{3}m$]. The low-temperature structure is formed by a partial migration of hydrogen atoms from octahedral to nearby tetrahedral crystallographic sites in the face-centered cubic palladium lattice. Approximate values of the root-mean-square vibrational amplitude of the hydrogen atoms were determined to be 0.25 Å ($T = 293°K$) and 0.17 Å ($T = 4.2°K$). The anomalous behavior observed in measurements of the temperature dependence of the electrical resistivity and heat capacity of this compound is explained by the transfer of hydrogen atoms between lattice sites. (auth)

8092 FARADAY ROTATION AND SPIN-ORBIT SPLITTING OF THE F CENTER IN ALKALI HALIDES. J. Mort, Fritz Luety, and Frederick C. Brown (Univ. of Illinois, Urbana). Phys. Rev., 137: A566-73(Jan. 18, 1965).

The energy-level structure of the F center in alkali-halide crystals was investigated by means of the Faraday effect. It was found that the Faraday angle is composed of two parts, a small high-temperature contribution and a paramagnetic rotation which can be quite large at low temperatures. The results for a number of alkali halides can be consistently interpreted in terms of an energy-level diagram for the F center which includes unequal population of the ground state and a negative spin-orbit splitting of the unrelaxed excited state. The magnitudes of spin-orbit splitting are generally less than the F-band width but increase with atomic number of both the alkali and the halide ion. A comparison is made with theory. Certain additional observations are reported, for example, on the spin-lattice relaxation time of the ground state up to 50 kG. (auth)

8093 THEORY OF SPIN-ORBIT EFFECTS IN THE F BAND IN ALKALI HALIDES. David Young Smith (Univ. of Illinois, Urbana). Phys. Rev., 137: A574-82(Jan. 18, 1965).

A calculation of the spin-orbit splitting of the first optically excited state of the F center is reported. It is based on a tight-binding, static lattice model of the crystal and assumes a vacancy-centered electronic wave function for the F center. To satisfy the Pauli principle, the F-center state must be orthogonalized to the occupied states of the crystal. This process modifies the vacancy-centered wave function by introducing states localized about the ions. These states undergo a spin-orbit interaction in the fields of the ionic nuclei, causing a splitting of the F band into two components. Explicit calculations for NaCl predict splittings of about 0.008 ev with the $P_{\frac{1}{2}}$ state lying above the $P_{\frac{3}{2}}$ state, in good agreement with the observed splittings. The calculations indicate that the spin-orbit splitting is determined primarily by the halide ion in the halides of light alkalies and generally increases with the atomic number of both ions. It further suggests that the structure in the F band of the cesium salts is due, at least in part, to a spin-orbit splitting. (auth)

8094 EFFECT OF APPLIED FIELDS ON THE OPTICAL PROPERTIES OF COLOR CENTERS. Charles H. Henry, Stephen E. Schnatterly, and Charles P. Slichter (Univ. of Illinois, Urbana). Phys. Rev., 137: A583-602 (Jan. 18, 1965). (COO-1198-193)

A theoretical analysis is made of the effect of an external perturbation, such as an electric field, magnetic field, or stress, on the optical properties of color centers. The analysis is restricted to centers with orbital singlet ground states. It is especially applicable to centers with orbitally degenerate excited states which are interacting strongly with the lattice, such as the F center in the alkali halides. The changes in the optical properties are described by computing the changes in the moments of the optical absorption line shape that occur when the external perturbation is applied. The changes in the zeroth, first, second, and third moments may be computed quite simply. Although this computation does not give the detailed change in the line shape, it provides a precise method for evaluating parameters of the center, such as the spin-orbit coupling constant of the excited state of the F center. The method of moments is used to analyze experiments on the circular dichroism, Faraday rotation, Stark effect, Voigt effect, and stress-induced dichroism of the F center and the circular dichroism of the A center. By analyzing the circular-dichroism or stress-induced-dichroism data for an F band, contributions to the broadening of the band by the cubic and noncubic lattice-vibrational modes can be evaluated. The data of Margerie and Romestain on the circular dichroism of the F band in CsBr and CsCl were analyzed. The analysis resolves the discrepancy between their two methods of determining the spin-orbit splitting (measurement of the peak separation and measurement of the circular dichroism) and shows that the splitting arises from a combination of a large spin-orbit coupling and a large noncubic lattice-vibrational interaction. (auth)

8095 MECHANISM OF ELECTRON EMISSION PRODUCED BY A GIANT-PULSE LASER. J. F. Ready (Honeywell Research Center, Hopkins, Minn.). Phys. Rev., 137: A620-3(Jan. 18, 1965).

A spinning-prism Q-switched ruby laser, with a peak power output of 2 Mw, was employed to produce single pulses of electron emission about 100 nsec long. Pulses of the order of hundreds of mamp/cm^2 were emitted from well-cleaned tungsten, thoriated tungsten, and platinum targets in a hydrogen atmosphere at 3×10^{-8} torr. The mechanisms for production of the electrons were investigated. No component attributable to multiphoton or other nonlinear processes was identified. The amplitudes and shapes of the electron pulses agree with calculated values based on the assumption that all the electron emission is produced by conventional thermal effects. (auth)

8096 AUGER-TYPE ELECTRON EJECTION FROM THE (111) FACE OF NICKEL BY SLOW He^+, Ne^+, AND Ar^+ IONS. Y. Takeishi and H. D. Hagstrum (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 137: A641-7(Jan. 18, 1965).

Experimental results concerning electron ejection from the atomically clean (111) face of nickel by singly charged ions of He, Ne, and Ar are reported. Total yield and kinetic-energy distribution of ejected electrons were measured as functions of ion energy in the range 4 to 100 ev. Revised experimental procedures made it possible to extend the range of useful incident ion energies from the previous 10-ev lower limit down to 4 ev. Significant differences in the electron energy distributions are observed for ions whose energies differ by as little as 1 ev. The measured electron energy distributions were found to be markedly different from those observed for silicon and germanium as well as for tungsten and molybdenum. This effect

is the result of differing state densities in the filled bands of these materials. The basic features of the results are discussed briefly. Data demonstrating the cleanness of the surface and the effects of adsorption of oxygen, carbon monoxide, and hydrogen are also presented. (auth)

8097 SURFACE IONIZATION OF SOME RARE EARTHS ON TUNGSTEN. M. J. Dresser and D. E. Hudson (Ames Lab., Ames, Iowa). Phys. Rev., 137: A673-? (Jan. 18, 1965). (IS-922)

The surface ionization of Gd, Er, and Yb atomic beams on a clean (112) tungsten surface was studied in an ultra-high-vacuum mass spectrometer. The absolute ionization efficiencies were determined as a function of surface temperature. The degree of ionization α was found to follow the general form of the Saha-Langmuir equation $A\ \alpha = Ae^{-E/kT}$. The magnitudes of A and E, however, are not consistent with the predicted values. Experimental and theoretical values of A and E are summarized. The Saha-Langmuir theory was found to be inadequate for the surface ionization of complicated atoms in beams on single-crystal tungsten surfaces. An auxiliary measurement of the work function of the (112) surface of tungsten yielded 4.85 ± 0.07 ev. (auth)

8098 PHOTOIONIZATION OF THE 4d ELECTRONS IN XENON. D. L. Ederer (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Letters, 13: 760-2(Dec. 21, 1964).

A study of the photoionization properties of the 4d electrons in xenon is presented. Instead of the orthodox hydrogenic form one assumes for inner-shell photoionization in elements of large Z, it was found that the photoionization cross section of the 4d electrons in xenon rises to a prominent peak about 32 ev above threshold and drops rapidly thereafter. The cross section at the peak is almost a full order of magnitude greater than the cross section at threshold. (C.E.S.)

8099 INTERACTION OF MAXIMA IN THE ABSORPTION OF SOFT X RAYS. John W. Cooper (National Bureau of Standards, Washington, D. C.). Phys. Rev. Letters, 13: 762-4(Dec. 21, 1964).

It is pointed out that the previously observed maxima in the photoabsorption cross sections of Ar and Xe are predictable by a one-electron nonhydrogenic central-field model. (C.E.S.)

8100 DIRECT SPECTROSCOPIC EVIDENCE OF BOUND STATES OF $(H_2)_2$ COMPLEXES AT LOW TEMPERATURES. A. Watanabe and H. L. Welsh (Univ. of Toronto). Phys. Rev. Letters, 13: 810-12(Dec. 28, 1964).

In an experiment designed to obtain indirect evidence for bound states in $(H_2)_2$ complexes in hydrogen gas at low temperatures by observing a predicted increase in the collision-induced infrared absorption at temperatures less than 40°K, the expected diffuse absorption was accompanied by a number of relatively sharp lines. A frequency analysis of these lines showed that they could unquestionably be interpreted as transitions involving bound and virtual states of $(H_2)_2$ complexes. The evidence is that there are probably two bound and at least two detectable virtual states in the $(H_2)_2$ molecule which appears to have a dissociation energy of ~3.5 cm^{-1} or ~10 cal/mole. (C.E.S.)

8101 DISTORTED-WAVE CALCULATION OF ROTATIONAL EXCITATION OF N_2 BY SLOW ELECTRONS. Raymond C. Mjolsness (General Electric Co., Valley Forge, Penna. and Los Alamos Scientific Lab., N. Mex.) and Douglas H. Sampson. Phys. Rev. Letters, 13: 812-15 (Dec. 28, 1964).

It is shown that the discrepancies between experiment and theory for the rotational excitation cross section of N_2 by slow electrons can be resolved by distorted wave theory calculations. (C.E.S.)

8102 SCATTERING OF ELECTRONS BY IONIZED HELIUM. P. G. Burke (Atomic Energy Research Establishment, Harwell, Berks, Eng.), D. D. McVicar, and K. Smith. Proc. Phys. Soc. (London), 84: 749-59(Nov. 1964).

Phase shifts, for the scattering of electrons from $He^+(1s)$, from threshold to 40.8 ev were calculated in the close coupling approximation. The salient feature of the results is the resonant behavior of the phase shifts just below the second quantum threshold. The phase shifts are presented in the form of graphs. In addition, differential cross sections are given for Q(1s−2s), while total cross sections are given for Q(1s−3p) close to the excitation threshold. (auth)

8103 ELECTRON CAPTURE BY HELIUM IONS IN NEUTRAL HELIUM. R. McCarroll and K. Prasad (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 84: 807-13 (Nov. 1964).

The cross section for electron capture by helium ions in helium is derived using an expansion based on atomic orbitals. Full account is taken of momentum transfer and of the non-orthogonality of the initial and final state wave functions. Computations were performed for the range of energies from 100 ev to 1 Mev. (auth)

8104 A VARIATIONAL METHOD FOR THE ELECTRON-HYDROGEN THREE BODY PROBLEM. J. F. Waddington (London Univ.). Proc. Phys. Soc. (London), 84: 828-30(Nov. 1964).

The box variational method, used by Risberg and Percival, is extended to include both exchange and monopole distortion for triplet s-wave scattering. The errors are much greater than the change in the phase shift introduced by monopole distortion. (auth)

8105 MASS SPECTROMETRIC DETERMINATION OF THE DISSOCIATION ENERGY OF THE MOLECULES MgO, CaO, SrO, AND Sr_2O. J. Drowart, G. Exsteen, and G. Verhaegen (Universite Libre, Brussels). Trans. Faraday Soc., 60: 1920-33(Nov. 1964).

The dissociation energy of the molecules MgO, CaO, SrO was determined: $D_0^\circ(MgO) = 86 \pm 5$; $D_0^\circ(CaO) = 93 \pm 5$; $D_0(SrO) = 102 \pm 5$ kcal/mole. The ground state was considered to be $^1\Sigma$. This choice is discussed. A discussion of the literature values for D_0°(MgO, CaO, SrO) is made. The molecule Sr_2O was identified and its atomization energy determined: $\Delta H^\circ_{0,at}(Sr_2O) = 194 \pm 6$ kcal/mole. (auth)

8106 SCATTERING OF INTERMEDIATE ELECTRONS AT SMALL ANGLES— COMPARISON OF ABSOLUTE MEASUREMENTS ON GASES WITH THEORETICAL RESULTS ACCORDING TO LENZ. Joachim Kessler (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 182: 137-52 (1964). (In German)

Several experiments on small angle scattering were made previously, the results of which are not in agreement with Lenz's theoretical results commonly used in electron microscopy. Since these measurements were made on foils, a possible reason for the discrepancies seemed to be that scattering did not take place on isolated, spherical, neutral atoms as theory assumes. Although these conditions were fulfilled in the present experiments, there is no agreement with theoretical results based on Lenz's scattering cross sections except for neon, where Lenz's cross sections give very reliable values. The discrepancies are not explainable by a breakdown of the Born approximation, as would seem to be obvious because of the systematic increase of the discrepancies with atomic number. (auth)

8107 DETERMINATION OF EFFECTIVE CROSS SECTIONS FOR SMALL-ANGLE SCATTERING OF ELECTRONS. Joachim Kessler (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 182: 153-65(1964). (In German)

Cross sections for small angle scattering of electrons are determined from previous absolute measurements. Lenz's approximation of the cross sections proves to be valid, but in a very limited angular range for most elements. Determination of the cross sections shows that the Thomas-Fermi-Dirac model describes small angle scat-

tering much better than is commonly assumed, disregarding a very small range near 0° into which only a very small portion of the electrons is scattered. Lenz's method, however, yields the correct cross sections only in special cases and must not be as commonly used as in general practice. (auth)

8108 FORMATION OF HIGHLY EXCITED HYDROGEN ATOMS AS A RESULT OF CHARGE EXCHANGE OF PROTONS IN GASES. R. N. Ilin, B. I. Kikiani, B. A. Oparin, E. S. Solov'ev, and N. V. Fedorenko (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 47: 1235-42(Oct. 1964). (In Russian)

The formation of highly excited hydrogen atoms with principal quantum numbers $n \geq 8$ as a result of charge exchange of 60 to 180 kev protons in molecular gases of H_2, N_2, and CO_2 was investigated. The relative yield of the highly excited atoms was determined by ionizing them in a strong electric field (Lorentz ionization). The cross sections for capture into a state with n = 10 is estimated to be in the cases investigated of the order of 10^{-19} to 10^{-20} cm^2. (auth)

8109 ONE-CENTER VARIATION CALCULATIONS ON THREE-ELECTRON SYSTEMS: TRIATOMIC HYDROGEN, THE LITHIUM ATOM, AND THE HELIUM ION. Fredrick Louis Minn. Thesis, Chicago, Univ., of Illinois, 1964. 92p.

A program for solving the three-electron nonrelativistic time-independent Schroedinger equation by a one-center variation technique was written for the University of Illinois computer ILLIAC. A description of the method is given. The system of principal interest was the ground state of linear triatomic hydrogen. Results were that a 49-configuration wave function yielded only about 15% of the binding energy. The saddle-point H_3 distance was predicted moderately well, as were the other gross properties, such as the total energy and the electron density. Although convergence seemed slow, the one-center approximation itself was actually a quickly operating procedure and is worth further investigation. Other systems considered were the lithium atom and the helium ion. Here, convergence was very fast; virtually all the energy was obtained from about 10 configurations. Good approximations to six states of the lithium atom, $^2S(1s^22s)$, $^2S(1s^23s)$, $^2P(1s^22p)$, $^2P(1s^23p)$, $^4P(1s2s2p)$, and $^4P(1s2p^2)$, and excellent approximations to two excited states of the helium ion, $^4P(1s2s2p)$ and $^4P(1s2p^2)$, were obtained. An evaluation of the method and suggestions for further work are given. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8110 ATOMIC BEAM SCATTERING STUDIES ON THE Li–Hg SYSTEM: VELOCITY DEPENDENCE OF TOTAL AND DIFFERENTIAL CROSS SECTIONS AS A ROUTE TO THE INTERACTION POTENTIAL. Peter John Groblicki. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 88p.

Methods for the elucidation of the interatomic potential are investigated, taking advantage of quantum effects observed in the scattering of low reduced-mass systems at thermal energies. Experimental data on the velocity dependence of total and differential elastic cross sections for the Li–Hg system are presented and compared with theoretical predictions. The Lennard-Jones (12, 6) potential function is used in the theoretical analysis. Computations are carried out employing a wide range of potential parameters appropriate to light-atom systems. The partial wave method is used to calculate angular distributions and total cross sections. In addition, semiclassical procedures are used to facilitate interpretation of the total cross section data. Methods are developed to correlate and interpolate the calculated angular scattering patterns and the total cross sections. Experimental scattering measurements were carried out for the isotopic system ^{6}Li–Hg and ^{7}Li–Hg. The experimental differential cross sections show interferences or "undulations," as predicted theoretically for systems whose deBroglie wavelength is of the order of atomic dimensions. Scattering patterns for ^{6}Li–Hg are found to be identical with patterns for ^{7}Li–Hg for experiments at the same deBroglie wavelength. The overall angular dependence of the scattering at low angles is in accord with predictions based on an assumed long-range inverse sixth power attractive potential. Although the precision of the present experiments is insufficient to allow the deduction of a unique set of L.–J. (12, 6) potential parameters, it has been shown that σ for Li–Hg is significantly less than the values of σ for the Li-rare gas systems, while ϵ/k for Li–Hg is greater than the comparable quantity for the Li-rare gas di-atoms. (A.G.W.)

8111 HALL MOBILITY OF ELECTRONS IN ALKALI HALIDE CRYSTALS. Richard Keith Ahrenkiel. Thesis, Chicago, Univ. of Illinois, 1964. 159p.

The Hall mobility of electrons released from F centers was measured in several different alkali halides in the temperature range of 7 to 100°K by an improved technique. In KBr, the mobility increases from about 100 cm^2/volt sec at 85°K to as high as 15,000 cm^2/volt sec at 6°K. The mobility is primarily due to optical mode scattering between 85 and 40°K with a Debye temperature of about 240°K. The mobility between 40 and 25°K appears to be influenced by acoustical mode scattering, and below 25°K, the mobility varies approximately as the inverse square root of the F-center density. If part of the F centers are converted to F' and α centers by irradiation in the F band at 120°K, the mobility at 6°K is found to decrease about an order of magnitude. The mobility is found to increase toward the original values as the F' and α centers are destroyed by bleaching light. Simultaneously, the F' photoresponse is found to first increase to a maximum and then decrease to zero. A few tests on zone refined KCl gave low temperature mobilities in lightly colored crystals about three times larger than found in Harshaw material. The temperature dependence of the mobility in KI is quite similar to that found in KBr. In NaCl, the low temperature mobility is about 1000 cm^2/volt sec independent of the F-center density. A steep decrease in mobility begins at about 40°K due to optical mode scattering. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8112 LYMAN ALPHA EMISSION FROM COLLISIONS INVOLVING MOLECULAR SYSTEMS. Bert Van Zyl. Thesis, Seattle, Univ. of Washington, 1963, 79p.

Cross sections for the emission of Lyman alpha radiation were measured for the following impacting ion-target combinations: $H^+ + N_2$; H^+, D^+, and $He^+ + H_2$; and H_2^+ + He, Ne, Ar, Kr, and Xe. Measurements cover the energy range of 1 to 25 kev. The $H^+ + N_2$ and H_2 cross sections show evidence of a dual peak structure similar to that exhibited by the earlier proton-rare gas data reported from this laboratory. The mechanism most likely responsible for the second maximum is shown to be cascade contributions to the Lyman alpha signal resulting from charge exchange to the excited states of the neutralized H atom for which $n \geq 3$. Similar structure is present in the cross sections for the H_2^+-rare gas collisions. The Lyman alpha emission cross sections for breakup of the incident H_2^+ ion on the rare gases and those for breakup of the target H_2 do not exhibit this dual structure. All data presented are the averages of two or more independent runs. The points are usually reproducible to within ±5% and the probable errors range from ±45% to ±65%. No correction was made for polarization effects. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8113 THE ENERGY LOSS OF ELECTRONS IN THIN FILMS. Andrew Michael Rauth. Thesis, New Haven, Yale Univ., 1962, 124p.

The total transmitted energy loss distribution of an initially monoenergetic electron beam was measured for thin films of varying atomic number. The films were thin enough (100–1500Å) and the incident electrons energetic enough (5–20 kev) so that the scattering distributions observed were representative of single and plural scattering. The distribution of energy losses above 100 ev for the organic films appeared consistent with W^{-2} dependence,

where W is the energy lost by the electron. From the experimental energy loss distributions measured, the average energy loss per inelastic event, $\bar{K}$, for Formvar ($C_5H_8O_2$), polystyrene (C_8H_8), and carbon was found to be approximately 60 ± 10 ev. For the other films investigated Al_2O_3, Al, Cu, Ag, and Au, $\bar{K}$ was found to increase with the mean atomic number of the target material. In addition to the energy loss distributions, data were obtained on the angular scattering distributions for the above films as a function of film thickness and the nature of the scattering event, i.e. elastic or inelastic. The elastic scattering distributions were characteristic of the target material and agreed quite well with previous electron diffraction work. (Dissertation Abstr., 25: No. 2 (Aug.1964))

8114 NUCLEAR MAGNETIC RELAXATION IN ION SOLUTIONS. K. Suess. Thesis, Stuttgart, Technische Hochschule, 1963. 48p. $2.00(Gmelin, AED-DISS. 63-612). (In German)

The design of an apparatus for nuclear magnetic relaxation time measurements using a pulse system is described. Relaxation times for various alkaline elements in aqueous solutions were measured. Dipole and quadrupole relaxation was compared. Magnetic interaction between alkaline nuclei in samples containing additional paramagnetic ions and electron moments was studied. A comparison with electron proton coupling was made. (Gmelin Inst.)

8115 NUCLEAR RESONANCE MEASUREMENTS IN LIQUID WATER UP TO THE CRITICAL POINT. R. Hausser. Thesis, Stuttgart, Technische Hochschule, 1964. 79p. $2.00(Gmelin, AED-DISS. 64-47). (In German)

Results of measurements of the self-diffusion coefficient of protons in liquid water are in agreement with theoretical predictions. Measured values of spin-lattice relaxation times are explained by means of a model based on statistic isotropic motion and magnetic dipole-dipole interaction between protons. This model is valid up to 130°C. The influence of radiation damping on measurements of the transversal relaxation time is discussed. (Gmelin Inst.)

8116 NUCLEAR-PUMPING OF GAS LASER SYSTEMS. Lloyd O. Herwig (United Aircraft Corp., East Hartford, Conn.). 30p. (CONF-446-52)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The present status of concepts and calculations concerning the excitation of an inverted population of atomic states in a laser gas medium through stopping of energetic heavy nuclear particles is summarized. The calculations indicate that nuclear stored energy can be applied directly to pump a gas laser system into continuous oscillation. Some arguments are presented which indicate that nuclear-pumped gas lasers have advantages over conventionally pumped gas lasers in areas such as laser beam intensity and control and in application of energy from a compact energy source. (auth)

8117 LANDAU LEVEL OSCILLATIONS IN THE MAGNETOACOUSTIC ABSORPTION IN ZINC. H. V. Bohm and L. Mackinnon (Wayne State Univ., Detroit). 9p. (CONF-651-24)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Zinc single crystals were used in low-temperature ultrasound propagation experiments using various orientations of magnetic fields and propagation directions. Results indicate that the magnetoacoustic technique can be used in observations of Landau level oscillation effects as precisely as can other techniques. This method can therefore be used in providing information on certain Fermi surface cross sectional areas and on caliper dimensions. (J.R.D.)

Cosmic Radiation

Refer also to abstracts 7742 and 8056.

8118 (NASA-TN-D-2516) RELAY I TRAPPED RADIATION MEASUREMENTS. C. E. McIlwain, R. W. Fillius, J. Valerio, and A. Dave (California. Univ., La Jolla, San Diego). Dec. 1964. Contracts NASr-116 and NAS 5-1683. 36p. $2.00 (OTS).

Instruments aboard the Relay I satellite have measured the intensities of geomagnetically trapped electrons with energies greater than 0.45 Mev and of protons in four energy ranges between 1 and 60 Mev over the region between 1.2 and 2.3 earth radii during the year 1963. The equatorial intensity of electrons (E > 0.45 Mev) was found to decrease monotonically from a maximum intensity of about 0.7×10^8 at 1.3 earth radii down to 10^5 sec^{-1} cm^{-2} ster^{-1} at 2.3 earth radii. The principal maximum in the proton intensities was found to occur on consistently higher lines of force and with increasing intensities toward lower energies such that a maximum intensity of about 3×10^6 protons (E > 1.1 Mev) sec^{-1} cm^{-2} ster^{-1} occurs at about 2.3 earth radii compared with the maximum of 1.95×10^5 protons (E = 40 to 110 Mev) sec^{-1} cm^{-2} ster^{-1} at 1.5 earth radii. A large decrease in the proton intensities at L values greater than 2.2 earth radii occurred during the magnetic storm of September 22-23, 1963. (auth)

8119 TIME DECAY OF THE ARTIFICIAL RADIATION BELT. C. O. Bostrom and D. J. Williams (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 70: 240-2 (Jan. 1, 1965).

Electron fluxes in the artificial radiation belt were measured for periods in October 1963, and March 1964, using a surface-barrier electron spectrometer on the satellite 1963 38C. The mean lifetime for electrons with energies > 1.2 Mev is presented as a function of magnetic field for earth radii from 1.2 to 1.6. The average dose rate to the satellite was computed for the two periods. (M.J.T.)

8120 TWO SOURCES OF COSMIC X-RAYS IN SCORPIUS AND SAGITTARIUS. R. Giacconi (American Science and Engineering, Inc., Cambridge, Mass.). H. Gursky, J. R. Waters, G. Clark, and B. Rossi. Nature, 204: 981-2 (Dec. 5, 1964).

Two separate and intense sources of cosmic x rays were observed in the region of the constellations Scorpius and Sagittarius during a rocket experiment launched on August 28, 1964. The detector was a bank of argon-filled Geiger tubes with beryllium windows and a total sensitive area of 70 cm^2. Data are presented in graphs. (M.C.G.)

8121 UPPER LIMIT TO JUPITER'S X-RAY FLUX ON SEPTEMBER 30, 1962. Philip C. Fisher, Dwight B. Clark, Arthur J. Meyerott, and Kermit L. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). Nature, 204: 982-3 (Dec. 5, 1964).

Three successive scans were made to detect x rays associated with Jupiter's radiation belts by a proportional counter flown on an Aerobee rocket launched from Wallops Island, Virginia. Although significant x-ray fluxes were observed, no x-ray flux from Jupiter was detected. The observations led to a conservative upper limit of 2.4×10^{-8} ergs/cm^2 sec for the flux of 4 to 8 kev photons from Jupiter. (M.C.G.)

8122 DOWNWARD ELECTRON FLUX AT 1,000 KM ALTITUDE FROM ELECTRON CONTENT MEASUREMENT AT MID-LATITUDES. P. R. Arendt and H. Soicher (Army Electronics Labs., Fort Monmouth, N. J.). Nature, 204: 983-4(Dec. 5, 1964).

Previously, in describing the diurnal variation of ionospheric electron content during Nov. and Dec. 1961, at mid-latitudes, the existence of a secondary maximum of ionization content below 1,000 km altitude for a period shortly after midnight. The diurnal variation curve obtained was smoothed by normalizing each single observation of it with respect to the corresponding 10.7-cm radiation $S_{10.7}$, which is an indicator of solar activity. The normalization failed to remove the midnight ionization content enhancement. This indicated that the content increase in regions below 1,000 km is real. Mechanisms contributing to its production are discussed. (M.C.G.)

8123 A HEURISTIC MODEL FOR THE VARIATION WITH RIGIDITY OF THE COSMIC-RAY CHARGE SPEC-

TRUM. M. F. Kaplon and G. Skadron (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 34: 1687-1711(Dec. 16, 1964). (UR-875-39)

An idealized model based on the supernova origin of cosmic radiation is proposed to account for the variation with rigidity of the cosmic-ray charge spectrum. It is assumed that a supernova explosion results in the injection of a pure power-law spectrum and a composition relatively rich in heavy nuclei. Particles are confined within a volume local to the source region by a magnetic boundary resulting in a rigidity-dependent coefficient of reflectivity; this yields a source-region path length varying inversely with rigidity. As a result, the differential spectra of particles escaping from the boundary into the galaxy are determined by the reflectivity; and as a result of the nuclear interactions in the source region, the composition varies with rigidity. The additional effect of intragalactic motion is taken into account and the differential rigidity spectra, as a function of composition at the earth, are calculated. Predictions for the H/M, L/M and $^3He/^4He$ ratios as a function of rigidity as well as the differential rigidity spectra are compared with experiment and are not in disagreement with the available data. The limitations and plausibility of the model are summarized and discussed. (auth)

8124 DETERMINATION OF THE ENERGY ABSORBED IN WATER FROM RELATIVISTIC COSMIC RAY PARTICLES USING THE ČERENKOV EFFECT. S. C. Lillicrap (Royal Cancer Hospital, London and Royal Marsden Hospital, Surrey, Eng.). Phys. Med. Biol., 10: 17-24(1965).

A method for measuring the dose received from high energy cosmic rays using a water Cherenkov detector is described. The amount of Cherenkov light produced is a measure of the energy absorbed in the detector from the incident particles. From an analysis of the shape of the spectrum of absorbed energies it was possible to estimate the contributions to the dose from the muon component and electron-photon component separately. A total whole-body dose rate of 26 ± 1.5 milliRad/year was found. This figure would probably be reduced by 1 or 2 milliRad/year inside buildings, due mainly to absorption of the electron-photon component. (auth)

8125 MEASUREMENT OF LOW-ENERGY PRIMARY COSMIC-RAY PROTONS ON IMP-1 SATELLITE. F. B. McDonald and G. H. Ludwig (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Letters, 13: 783-5(Dec. 28, 1964).

The intensity and energy spectra of primary cosmic protons in the 15- to 75-Mev range were determined. The measurements reported are considered to be representative of the period just prior to solar minimum. The proton intensity was observed to be 19 protons m^{-2} sec^{-1} $sterad^{-1}$ or approximately 1% of the total primary cosmic ray intensity and to exhibit a steeply falling energy spectrum toward lower energies. (C.E.S.)

8126 DETECTION OF INTERPLANETARY 3- TO 12-Mev ELECTRONS. T. L. Cline, G. H. Ludwig, and F. B. McDonald (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Letters, 13: 786-9(Dec. 28, 1964).

The direct observation of interplanetary electrons of energy above 3 Mev is reported. It is demonstrated that the flux of lower energy electrons observed is a primary component of the interplanetary radiation, and the properties of the flux are discussed in terms of its possible origin. (C.E.S.)

8127 GEOMAGNETIC EFFECTS OF COSMIC RAY ELECTRON INTENSITY. Haruyuki Okuda (Nagoya Univ., Japan). Rept. Ionosphere Space Res. Japan, 17: 1-12 (1963).

As a preliminary study of the observation of the positron-electron ratio and the energy spectrum of cosmic electrons, the geomagnetic effects on their intensity, i.e., the azimuthal dependences at several latitudes and the latitude dependence of the vertical intensity are calculated. A possibility for deriving information on the origin of cosmic electrons from the azimuthal dependence is discussed by referring to their observational conditions. It is also shown that the observation of latitude dependence is useful for the investigation of the modulation mechanism of cosmic rays in interplanetary space. (auth)

8128 THE ORIGIN OF COSMIC RAYS. Satio Hayakawa (Nagoya, Univ. Japan). p.1-164 of "Lectures on Astrophysics and Weak Interactions. Vol. 2." Waltham, Mass., Brandeis University, 1963.

A brief description of the astronomical information necessary for cosmic ray studies is given. The composition, energy spectrum, anisotropy and secular variation of primary cosmic rays, and their interactions in interstellar and metagalactic space are investigated. Synchrotron radiation in the Crab Nebula and other supernova remnants, radio galaxies, and acceleration mechanisms for cosmic ray origin are discussed. (L.B.S.)

8129 THE TIME DEPENDENCE OF RADIATION BELT LIFETIMES AND SOME APPLICATIONS. Forrest E. England (Univ. of Maryland, College Park). 113p. (CONF-452-62)

From American Physical Society, Washington, D. C., Apr. 1964.

The lifetimes of particles in the radiation belt vary as a consequence of fluctuations of the loss processes such as produced by variations of atmospheric density with time. The time scale of atmospheric variations affects the averaged atmospheric density to which trapped particles are exposed and therefore determines the time dependence of the radiation lifetimes as set by the atmosphere. Since observations are usually made of the radiation flux rather than of lifetime, a number of models of injection and loss, which determine the resultant flux, are examined. Special cases of injection and removal are considered. Artificial injections such as Starfish can be used to investigate the particle lifetimes. Similarly, artificial removal by sweeper satellites is shown to modify the radiation belt in such a way as to enable physical properties of the radiation belt and its environment to be deduced. (auth)

Direct Energy Conversion

8130 (MHD-655) EXPLOSIVE MAGNETOHYDRODYNAMICS. First Quarterly Technical Progress Report, April 1–June 30, 1964. Malcolm S. Jones, Jr., and Francis H. Webb, Jr. (MHD Research, Inc., Newport Beach, Calif.). July 13, 1964. Contract AF33(615)-1594. 47p. (AD-602811). $3.00(OTS).

Experimental and theoretical studies on the production of high energy, short duration pulses of electrical power by MHD principles are discussed. Previous work in a 1-inch by 1-inch cross section channel and a 1-inch by 4-inch cross section channel using cesium-seeded condensed explosives, which produced tens of megawatts of electrical power in pulses of approximately 100 μsec, is expanded. A program for a 2-inch by 6-inch cross section linear channel and for a radial geometry generator is discussed. Power generation appears to be proportional to the square of the velocity of the conducting front. Lumped parameter circuit theory analyses are presented and expressions derived which may be used to determine the amount of energy removed from the slug as a function of distance along the channel and the generator geometry. (auth)

8131 (MND-3100) A STUDY PROGRAM ON CESIUM VAPOR-FILLED THERMIONIC CONVERTERS HAVING HIGH VACUUM WORK FUNCTION EMITTER MATERIALS. Yearly Summary Report, November 1, 1962–October 31, 1963. D. S. Trimmer, A. J. Kennedy, and M. E. Talaat (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract Nonr-3639(00). 138p. (AD-422395). $10.50(OTS).

An extensive mapping of the performance of cesium vapor-filled thermionic energy conversion devices was obtained for the high vacuum work function emitter materials iridium and rhenium. Characteristic current versus voltage curves and summaries of the output power density

are given for the emitter temperature range of 1600–2100°K, the liquid cesium temperature range of 450–675°K, the collector temperature range of 555–1075°K, and for interelectrode spacing from 0.004 to 0.052 in. The devices used in this program were of flat-plate geometry and were so designed that the interelectrode spacing could be varied accurately and continuously under the conditions that the other test parameters were maintained constant. Consequently, the dependence of performance on interelectrode spacing could be measured to high precision. At low cesium pressure, the best performance is obtained at the widest interelectrode spacing. For the intermediate range of cesium pressures, the best performance is obtained at intermediate (0.012–0.032 in.) values of the interelectrode gap. At the highest cesium pressures, the best performance is obtained at the closest spacings. (auth)

8132 (NP-14492) NEW METHODS OF POWER GENERATION. Advisory Committee Report No. 8. (Federal Power Commission. Bureau of Power, San Francisco). Apr. 1963. 14p.

The development and future potentials of thermionic and thermoelectric converters, fuel cells, MHD generators, and thermonuclear reactors, as regards their uses for electric power production, are outlined. (T.F.H.)

8133 (NP-14538) DIRECT ENERGY CONVERSION SYSTEMS. Quarterly Technical Summary Report, June 1, 1964–August 31, 1964. Robert H. Eustis (Stanford Univ., Calif.). Sept. 30, 1964. Contract AT49(638)-1123. 101p.

The MGD generator electrode materials problem has been greatly simplified by introducing cooling water into the electrode stems. Runs of over one-half hour duration indicate a negligible recession of the surface so that the same electrodes can be used for several runs. Electrical data from the generator indicates a diffuse current with an applied electric field for currents up to about 10 amperes per electrode (current density of about 1 amp/cm^2). Current leakage through the insulating brick has been examined and some changes in brick design and material are being made to reduce this leakage. A more complete report than that previously given is made of the investigation of the influence of the Ramsauer effect on nonequilibrium electron temperatures. The calculation of electrical conductivity by the Chapman-Enskog method has been compared to the method of Frost. Very satisfactory agreement has been shown and the assumptions of Frost have been given a more rigorous foundation. Diagnostic methods have been improved with the development of the spectroscopic line reversal technique. Temperature measurements believed accurate to ±10°K have been made in seeded flames. An investigation of the effect of free stream turbulence on the limiting current density at the front stagnation point of a translating cylinder electrode was undertaken. An effect of the cylinder diameter and whether the electrode was cathodic or anodic was observed. (auth)

8134 SOLAR ENERGY THERMIONIC ELECTRICAL POWER SUPPLIES. W. R. Menetrey (Electro-Optical Systems, Inc., Pasadena, Calif.) and A. Smith. J. Spacecraft Rockets, 1: 659-65(Nov.-Dec. 1964).

The status of solar energy thermionic (SET) electric power supplies under development by NASA is described. A system efficiency of 3.3% and a specific weight of 1.5 w/lb was demonstrated in September 1962 in the first prototype system test using solar energy. A thermionic generator tested more recently has produced 82 w with an efficiency of 7.5% using electron bombardment heating to simulate solar energy. SET converters have produced up to 20 w/cm^2 at 0.8 v output and 1700°C observed emitter temperature. Five SET converters operated for over 3000 hr at an observed emitter temperature of 1700°C. A 9.5-ft-dia nickel master was successfully fabricated using an epoxy spincasting process and nickel electroforming. The development effort is expected to result in SET electric power supplies possessing advantages of higher conversion efficiency, lower weight, and increased reliability for many of the space missions of interest in the next ten years. (auth)

8135 ENHANCEMENT OF THE ELECTRICAL CONDUCTIVITY OF SEEDED RARE GASES IN ELECTRIC FIELD. S. Yano, S. Matsunaga, T. Hiramoto, and H. Shirakata (Japan Atomic Energy Research Inst., Tokyo). 10p. (CONF-640701-100)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The conductivity of K-seeded Ar gas was measured. Results of these measurements are discussed along with factors affecting the enhancement of conductivity. Other discussions are included concerning theoretical aspects of conductivity and experimental results. (J.R.D.)

8136 PHOTOIONIZATION IN MPD GENERATORS. D. Balfour (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.) and J. H. Harris. 12p. (CONF-640701-65)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

A model of a generator duct is considered in which a beam of u-v radiation is directed through gas transverse to its flow direction immediately before entering the region of the electrodes. The increase in power output of such a generator resulting from a known input of u-v energy is estimated in terms of the photoionization cross section for Cs and the collision frequencies of the electrons with He atoms and Cs ions and atoms. Experimental data on photoionization and on recombination are included. (J.R.D.)

Elementary Particles and Radiations

Refer also to abstracts 8063, 8281, and 8446.

8137 (JINR-E-1820) SMALL-ANGLE ELASTIC p-p AND p-d SCATTERING IN THE ENERGY RANGE OF 2-10 Gev. L. F. Kirillova, V. A. Nikitin, V. S. Pantuev, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 14p. Dep.(mn).

The results of measurements of the differential cross sections for elastic scattering of protons by protons and by deuterons at 2, 4, 6, 8, and 10 Bev are reported. The investigated region of momentum transfer is 3.10^{-3} Bev^2/c$^2 \leq |t| \leq 0.2$ Bev^2/c^2. The measurements of the interference of the coulomb and nuclear scattering yield information on the magnitude of the real part of the elastic p-p scattering amplitude. For E_{kin} = 10 Bev, ReA = −0.25 ± 0.07 ImA; for E_{kin} = 2 Bev, ReA = −0.17 ± 0.07 ImA. The results of the experiments are compared with the dispersion relations predictions. (auth)

8138 (JINR-P-1838) REAKTSIYA $\pi^- p \rightarrow \pi^+\pi^- n$ VBLIZI POROGA II SPEKTRY EFFEKTIVNYKH MASS $\pi^+\pi^-$ I $\pi^+ n$-SISTEM. OPREDELENIE DLIN π-π-RASSEYANIYA V. S-SOSTOYANII. (The Reaction $\pi^- p \rightarrow \pi^+\pi^- n$ Near the Threshold. II. The Effective Mass Spectra for $\pi^+\pi^-$ and $\pi^+ n$-Systems. A Determination of $\pi\pi$ Scattering Lengths in the S-State). Yu. A. Batusov, S. A. Bunyatov, V. M. Sidorov, and V. A. Yarba (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 10p. Dep.(mn).

The mass spectra of ($\pi^+\pi^-$) and ($\pi^+ n$) systems from the reaction $\pi^- p \rightarrow \pi^+\pi^- n$ in the 280 to 350 Mev energy range are investigated. The analysis of the energy and angular distributions of secondary particles with an accuracy up to the linear terms in relative momenta shows that the difference between the ($\pi\pi$) scattering lengths is equal to +(0.25 ± 0.05) h/μc. (auth)

8139 (NEVIS-126) DETERMINATION OF Σ–Λ RELATIVE PARITY. Cynthia Alff Steinberger, N. Gelfand, U. Nauenberg, et al. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Oct. 1964. Contract AT(30-1)-1932. 43p. (R-457; CU-1932-232). Dep.(mn); $2.00(cy), 1(mn) OTS.

An experiment was performed to determine the Σ–Λ relative parity, through a study of the decay mode $\Sigma^0 \rightarrow$

$\Lambda^0 + e^+ + e^-$. The Σ^0 were produced by stopping K^- mesons in a 30-in. hydrogen chamber, via the reaction $K^- + p \rightarrow \Sigma^0 + \Pi^0$, and 314 events were identified. The experimental distribution of the combined mass of the electron-positron pair was compared to that predicted by theory. If it is assumed that the dependence of the form factors on the combined mass of the electron-positron pair can be neglected, and that the ratio of the electric form factor F_1 to the magnetic form factor F_2 is less than 6, then the data show that the $\Sigma - \Lambda$ relative parity is even. (auth)

8140 (NP-14479) PRODUCTION OF Σ HYPERON AND PION PAIRS. Technical Report. R. D. Hill and D. G. Ravenhall (Illinois. Univ., Urbana). Oct. 1964. 7p.

It is shown that a dynamical analysis of the reaction $K^- + {}^{12}C \rightarrow Y^{*0} + {}^{11}B + Q$, in which the Y^{*0} is given no a priori resonance properties, fails to yield a dynamical explanation for the narrowness (about 1.4 Mev) of the $\Sigma\pi$ pair production peak at 1405 Mev in this reaction. (T.F.H.)

8141 (TID-21338(p.190-2)) PRODUCTION OF POLARIZED PROTONS. M. R. Baker and L. Madansky (Johns Hopkins Univ., Baltimore).

A polarized-proton apparatus is described, which produces metastable atomic hydrogen beams by proton charge-exchange reactions with Li or Cs vapor. (T.F.H.)

8142 CONSEQUENCES OF ANALYTICITY AND UNITARITY FOR PARITIAL-WAVE AMPLITUDES. A. P. Balachandran and Frank von Hippel (Univ. of Chicago). Ann. Phys. (N. Y.), 30: 446-75(Dec. 1964). (EFINS-64-18)

Asymptotic and integral relation between the functions associated with the unphysical and physical spectral functions of partial-wave amplitudes with $l \geq 1$ for the scattering of spinless particles are developed. The results are used to show that: The function associated with the unphysical singularities must have a closely limited asymptotic behavior if the dispersion relation is to be consistent. The unphysical singularities determine precisely the leading asymptotic term in the function associated with the physical cut and in the absence of unphysical singularities, there can be no scattering. In many cases, the unphysical singularities determine the asymptotic limits of the transmission factor and the real part of the phase shift. If the transmission factor goes to zero (maximal inelasticity), the rate at which it approaches this limit is sometimes bounded by a known function. In these cases, the unphysical singularities and the transmission factor together determine the leading asymptotic term of the the phase shift. In some situations, a sign inconsistency in the asymptotic constraints implies the existence of poles in any N/D solution with residues whose signs prevent their interpretation as bound states. These poles are then ghosts. In an exact partial-wave dispersion relation, at least when $l \geq 2$, there is no simple way by which to determine, from the sign of the unphysical function at threshold or at infinity, whether the corresponding force is attractive or repulsive. This sign is fixed at these energies by general arguments. As a result of these constraints, one can conclude that the usual approximations of the unphysical cut in terms of the singularities of pole diagrams have a chance of satisfying consistency requirements only for the s- and p-waves with spin zero and one particle exchanges. For p-waves the exchange of a spin one particle is required. Certain rapidly convergent integral identities are developed which can be used to test for the presence of ghosts or of bound states in N/D solutions or to test the accuracy of solutions. Finally, the relativistic Chew-Low model is used to demonstrate numerically the importance of some of the restrictions obtained. (auth)

8143 APPLICATION OF THE METHOD OF MOMENTS TO PARTIAL-WAVE DISPERSION RELATIONS. I. THE SCATTERING OF SPIN ZERO PARTICLES. A. P. Balachandran (Univ. of Chicago). Ann. Phys. (N. Y.), 30: 476-515(Dec. 1964).

The partial-wave dispersion relation for the scattering of spinless particles is analyzed assuming that the discontinuity across the unphysical cut and the transmission factor are given. The requirement of the correct threshold behavior of the partial-wave amplitude is shown to lead to a moment problem where certain constants $\{\mu_\nu\}$, which by assumption are known, are expressed as the moments of a positive definite function. Conditions on $\{\mu_\nu\}$ are proved for the existence of solutions of the moment problem and therefore of the dispersion relation. Upper and lower bounds for certain energy dependent integrals involving the imaginary part of the partial wave are derived at all physical energies in terms of the moments $\{\mu_\nu\}$. Thus, in any model whose N/D solution is free of ghosts, it is possible to deduce the general behavior of the partial wave in the physical region from these bounds. They also show that any approximation which does not lead to ghosts and which reproduces the moments sufficiently well will have a solution accurate up to the specified errors in the physical region. Moment problems are also derived without appealing to the threshold behavior of the amplitude, but by taking advantage of some experimental information instead. The applications of these problems to model calculations are discussed in detail. It is pointed out that the values of the moments associated with any of these problems can be calculated from experiments. A phenomenological method of approximation based upon the knowledge of these moments is suggested which seems capable of reproducing the scattering amplitude in the physical region with some accuracy. The consequences of the bounds mentioned above for the ambiguities in the solution of the dispersion relation are examined. Inequalities are derived for the parameters of the poles introduced by N/D solutions which should prove useful in finding out whether the solutions of a particular model will contain ghosts or not. The distinction between the approximations based on the dominance of nearest singularities for form factors and peripheral collisions on the one hand and for partial-wave dispersion relations on the other is emphasized. (auth)

8144 ON THE INTERNAL DEGREES OF FREEDOM OF ELEMENTARY PARTICLES. Arne Kihlberg (Chalmers Tekniska Högskola, Göteborg). Arkiv Fysik, 28: 121-7 (1964).

The use of a six-vector (e,h), with $e \cdot h = 0$, $e^2 = h^2$, as internal coordinates for a particle in addition to its space time coordinates is examined. Using the operational definition of (e,h), an attempt is made to find an appropriate invariance group which can replace the inhomogeneous Lorentz group. Different choices are conceivable, however, and the case of a group that is isomorphic to the direct product of the inhomogeneous and the homogeneous Lorentz group is discussed. The connection between the quantum numbers of the elementary particles and the spectra of a unitary representation of the group is considered. (auth)

8145 MASSES OF THE T = 0 MESONS. Charles A. Coombes (Univ. of Alberta, Calgary, Can.). Can. J. Phys., 42: 2371(Nov. 1964).

If mesons are considered as bound fermion-antifermion states and if one takes into account the central role played by the Λ in unitary symmetry, one might consider the Λ to be the main contributor to the mass of the T = 0 mesons. On this basis the Fermi-Yang model and the equation of Vaks were used to calculate the masses of the T = 0 mesons. (C.E.S.)

8146 THE SPECTRAL FUNCTION FOR THE NUCLEON FORM FACTOR. M. Razavy (Univ. of Alberta, Edmonton, Can.). Can. J. Phys., 42: 2495-7(Dec. 1964).

The electromagnetic form factor G of the nucleon is an analytic function of the complex variable $z = t + iy$ in a plane cut from $t = t_0$ to $t = \infty$ and is related to the spectral function $g(t')$ by $G(z) = 1/\pi \int_{t_0}^{\infty} g(t')/t' - z\, dt'$, where the variable t is the negative of the four-momentum transfer squared, and t_0 is a positive number. A derivation is given for finding $g(t')$ from the analytic form of the real part of G(t). (C.E.S.)

8147 APPLICATION OF THE WILLIAMS-WEIZSACKER PICTURE TO THE HIGH ENERGY NUCLEON-

NUCLEON COLLISIONS. Kanji Fujii, Hideaki Nagai, Tetsuro Sakuma, and Tetsuya Tsuchida. J. Fac. Sci., Hokkaido Univ., Ser. II, 6: 1-10(May 1963).

An attempt is made to develop the Williams-Weizsäcker (W-W) method so as to be applicable to the nucleon-nucleon collisions at high energies. Under a certain condition, that is, in case of ⟨no excitation⟩ one of the colliding nucleons, it is shown that the W-W picture can be applicable to nucleon-nucleon collisions due to a peripheral pion exchange. On the basis of the modified W-W method, the total cross section of the high energy nucleon-nucleon collisions, σ_T, is estimated, and it is found that σ_T is constant at high energies if the pion-nucleon total cross section is assumed to be constant. The total number of almost real pions surrounding a physical nucleon is also estimated and is consistent with that obtained by Blokhinčev. Further, the correspondence between the W-W method and the perturbation theory is discussed, and results similar to those in electromagnetic processes are obtained. (auth)

8148 REDUCTION OF THE N-PARTICLE VARIATIONAL PROBLEM. Claude Garrod and Jerome K. Percus (New York Univ., New York). J. Math. Phys. (N. Y.), 5: 1756-76(Dec. 1964).

A variational method is presented which is applicable to N-particle boson or fermion systems with two-body interactions. For these systems the energy may be expressed in terms of the two-particle density matrix: $\Gamma(1, 2 \mid 1', 2') = (\Psi \mid a_2^\dagger a_1^\dagger a_{1'} a_{2'} \mid \Psi)$. In order to have the variational equation: $\delta E/\delta\Gamma = 0$ yield the correct ground-state density matrix Γ must be restricted to the set of density matrices which are actually derivable from N-particle boson (or fermion) systems. Subsidiary conditions are presented which are necessary and sufficient to ensure that Γ is so derivable. These conditions are of a form which render them unsuited for practical application. However the following necessary (but not sufficient) conditions are shown by some applications to yield good results: It is proven that if $\Gamma(1, 2 \mid 1', 2')$ and $\gamma(1 \mid 1')$ are the two-particle and one-particle density matrices of an N-particle system [normalized by $\mathrm{tr}\,\Gamma = N(N-1)$ and $\mathrm{tr}\gamma = N$] then the associated operator: $G(1, 2 \mid 1', 2') = \delta(1-1')\gamma(2 \mid 2') + \sigma\,\Gamma(1', 2 \mid 1, 2') - \gamma(2 \mid 1)\gamma(1' \mid 2')$ is a nonnegative operator. [Here σ is +1 or −1 for bosons or fermions respectively.] (auth)

8149 SEARCH FOR AN INTERMEDIATE BOSON BY ATMOSPHERIC NEUTRINOS. C. Castagnoli, A. De Marco, and P. Penengo (Università, Turin). Nucl. Phys. 63: 79-81(Mar. 1965).

The atmospheric neutrino component was used as a ν_μ source in a search for the existence of the intermediate boson predicted by Tanikawa and Watanabe. The experiment consisted of the measurement of the possible flux N_μ of muons upwards through a telescope of scintillators placed underground at a depth of 4100 m water equivalent. The experimental result is $N_\mu = 0$ in 7.7×10^6 sec and suggests a mass of the intermediate boson $M_B > 3500\ m_e$. (auth)

8150 A MODEL FOR BOSON-BARYON INTERACTIONS. J. Cumming (Ames Lab., Ames, Iowa). Nuovo Cimento (10), 34: 1152-66(Dec. 1, 1964). (IS-874)

The transitions of electrons from positive to negative energies were examined by Klein and Sauter, who investigated the results of including a potential step function in relativistic field equations. A possible physical significance of the Klein paradox is obtained by examining the effect of a repulsive square potential in the Klein-Gordon equation. It is found that scattering resonances can occur, and that the possibility exists of having bound states for bosons of suitable quantum numbers. The phenomenological model gives a reasonable fit to present pion-baryon data for strangeness 0 and −1. (auth)

8151 BARYON-BARYON INTERACTIONS AND UNITARY SYMMETRY. S. Iwao (Universität, Bern). Nuovo Cimento (10), 34: 1167-83(Dec. 1, 1964).

Baryon-baryon interactions are studied using the octet version of the unitary symmetry model. The bound state Ξ^-n in the $^1S_0$ state is predicted provided that symmetry is not violated seriously. The $\Xi^-n \to \Sigma^-\Sigma^0$ process occurs only through the space-spin symmetric state. A method to treat the symmetry violation in low-energy scattering is discussed. (auth)

8152 THE LOW-ENERGY Λ-$\mathcal{N}$ AND Λ-Λ INTERACTION. A. Deloff (Oxford Univ.) and J. Wrzecionko. Nuovo Cimento (10), 34: 1195-1224(Dec. 1, 1964).

The Λ-$\mathcal{N}$ and Λ-Λ potentials are derived from field theory by means of a perturbation-dispersion method. The two-pion-exchange potential is calculated from the Mandelstam representation for the Λ-$\mathcal{N}$ and Λ-Λ scattering amplitude in a one-channel formalism. The $\pi\Lambda$ scattering amplitude is introduced in the unitarity condition as an extension of the CGLN model for $\pi\mathcal{N}$ scattering, where contributions from Σ and Y_1^* are represented by appropriate pole terms. Since the TPE potential alone is not sufficient to reproduce the low-energy Λ-$\mathcal{N}$ scattering data, no attempt is made to fit the $\pi\Lambda\Sigma$ coupling constant. Forces due to scalar, pseudoscalar, and vector boson exchange are discussed and corresponding potentials are deduced in the one-particle-exchange approximation. (auth)

8153 POINT TRANSFORMATIONS AND SCATTERING BY A HARD CORE. F. M. Eger and E. P. Gross (Brandeis Univ., Waltham, Mass.). Nuovo Cimento (10), 34: 1225-41(Dec. 1, 1964).

The scattering of a particle by a hard-core potential is considered from the point of view of coordinate transformations. A transformation that deforms the radial coordinate leads to a regular velocity-dependent potential and a modified static potential. The arbitrary function involved may be chosen to reduce the core to arbitrarily small size for the transformed hamiltonian or remove it completely. If the deformation extends over all space, the phase shifts described by the new hamiltonian are displaced by the s-wave contribution. If the deformation tends to zero at large distances, all the scattering is contained in the hamiltonian. The transformation serves to generate a family of Hermitian, velocity-dependent potentials with the correct zero-energy scattering behavior. (auth)

8154 Λ-NUCLEON POTENTIAL. G. Fast, G. Ranft, and J. J. de Swart (CERN, Geneva). Nuovo Cimento (10), 34: 1242-53(Dec. 1, 1964).

Potentials to describe the hyperon-nucleon interaction were calculated previously with the prescription of Brueckner and Watson. These potentials treat the Λ and Σ channels on equal footing. They were used to calculate an effective potential for the lambda-nucleon interaction that takes the effect of the closed Σ channel into account only implicitly. The potentials used were in accordance with an even Λ-Σ parity and with unitary symmetry for the pseudovector coupling constants, which they contain as parameters. It is shown that the phase shifts resulting from the effective $\Lambda\mathcal{N}$ potential concide, up to about the threshold for Σ production, with the ones obtained from the original hyperon-nucleon potentials. Calculations were done both for the singlet and triplet cases. In this way, an impression is obtained about the effective amounts of central, spin-orbit, and tensor force in the $\Lambda\mathcal{N}$ interaction. (auth)

8155 ELECTROMAGNETIC MASS SPLITTINGS AND THE BARYON OCTET MASS FORMULA. M. Nauenberg (CERN, Geneva). Nuovo Cimento (10), 34: 1254-6(Dec. 1, 1964).

It is shown that in order to take into account the electromagnetic mass shifts of the baryons in testing the baryon octet mass formula, the mean mass of each baryon isospin multiplet may be used. (auth)

8156 A CONSTRUCTION OF THE FOLDY-WOUTHUYSEN TRANSFORMATION FOR ZERO-MASS PARTICLES OF ARBITRARY SPIN. J. Voisin (Université, Liège). Nuovo Cimento (10), 34: 1257-62(Dec. 1, 1964).

The Foldy-Wouthuysen transformation for zero-mass particles of spin s is constructed using a set of rotations in ordinary space having formally the desired effect. (auth)

8157 HIGH-ENERGY BEHAVIOR OF PARTIAL-WAVE AMPLITUDES. E. J. Squires (Univ. of Edinburgh). Nuovo Cimento (10), 34: 1277-82(Dec. 1, 1964).

It is shown that the assumptions of Regge behavior and the Mandelstam representation do not immediately yield useful information on the high-energy properties of partial-wave amplitudes. An additional assumption is suggested leading to a decreasing behavior, dominated on the right, but apparently not on the left, by crossed-channel Regge poles. (auth)

8158 THE ERIKSENLIKE TRANSFORMATION FOR THE RELATIVISTIC LIMIT OF SPIN-ONE PARTICLES. J. Beckers (Université, Liège). Nuovo Cimento (10), 34: 1283-8(Dec. 1, 1964).

The Cini-Touschek transformation for free or interacting spin-one particles is constructed by an Eriksen-Högaasen method. (auth)

8159 RELATIVISTIC TWO- AND THREE-PARTICLE STATES. A. McKerrell (Univ. of Glasgow). Nuovo Cimento (10), 34: 1289-1305(Dec. 1, 1964).

Two-particle states transforming according to standard representations of the inhomogeneous Lorentz group are constructed which, in the center-of-mass system, are eigenstates of orbital and spin angular momentum operators. The connection between these and helicity states is derived, and a recoupling coefficient for three-particle states in the former scheme found. (auth)

8160 LOW-ENERGY π-N SCATTERING AND THE UN-REGGEIZED STRIP APPROXIMATION. M. Der Sarkissian (Univ. of California, Livermore). Nuovo Cimento (10), 34: 1314-27(Dec. 1, 1964). (UCRL-7926-T)

A self-consistent study of low-energy π-N scattering is carried out, using the N/D method in the strip approximation. A numerical approximation scheme is developed which reduces the complicated integral equation for N to simple algebraic manipulations, thereby permitting a mathematically manageable solution of π-N dynamics without sacrificing the relativistic features of the problem. The solutions found by this method depend on one parameter, the strip width (W_1). The results are sensitive to changes in W_1, probably reflecting the inadequacy of the un-Reggeized strip approximation. There are good reasons for expecting the sensitivity to partially disappear in the Reggeized strip approximation. Only the p(3,3) and p(1,1) partial-wave amplitudes were studied. A resonant solution was found for the p(3,3) amplitude (called N^*), and a bound state solution for the p(1,1) amplitude (called N). The N^* that appeared in the direct channel has a mass (M_{33}^D) and reduced width (γ_{33}^D) given (in natural units) by $M_{33}^D = 8.9$ and $\gamma_{33}^D = 18$. These numbers are to be compared with the crossed N^* which was inserted with $M_{33} = 8.9$ and $\gamma_{33} = 7.5$. The N appeared in the direct channel with $M^D = 7.2$ and $\gamma_{11}^D = 22$. These numbers are to be compared with the crossed N with $M = 6.7$ and $\gamma_{11} = 15$. This theory may be considered a relativistic version of Chew's "Reciprocal Bootstrap" for the π-N system since only N and N^* were assumed to generate the forces acting in the direct channel. Introducing the ρ-meson contribution alters this reciprocal picture somewhat but not in any drastic way. (auth)

8161 A RANDOM-PHASE APPROXIMATION IN HIGH-ENERGY SCATTERING. E. J. Squires (Tait Inst. of Mathematical Physics, Edinburgh). Nuovo Cimento (10), 34: 1328-36(Dec. 1, 1964).

The equations of a multichannel N/D method are formulated, and it is suggested that the hypothesis of random signs for the elements of the force matrix considerably simplifies the solution. A simple model is treated and shown to yield a neat derivation of a formula which can be used to correct the peripheral model for coherent scattering effects. (auth)

8162 SINGLE PHOTON EMISSION IN HIGH-ENERGY e^+-e^- COLLISIONS. G. Altarelli and F. Buccella (Università, Florence). Nuovo Cimento (10), 34: 1337-46 (Dec. 1, 1964).

The angular distribution of emitted photons, their energy spectrum, and the total cross section for the emission of photons of energy $\geq \epsilon$ are evaluated in the extreme relativistic limit for the process $e^+ + e^- \rightarrow e^+ + e^- + \gamma$. (auth)

8163 A BOOTSTRAP MODEL OF THE ρ INCLUDING TWO-PION EXCHANGE FORCES. J. L. Gervais (Université, Paris). Nuovo Cimento (10), 34: 1347-60(Dec. 1, 1964).

An attempt is made to improve the ρ bootstrap model of Zachariasen and Zemach by adding the forces due to the exchange of two pions outside the ρ resonance, without spoiling the self-consistency, of the equations, in the one-channel problem. Contrary to the one-ρ-exchange forces, the forces considered are strong enough to generate the ρ, since ReD vanishes at the ρ mass when the physical value of the ρ-π-π coupling constant is put into the diagrams that give the forces. It is shown that the two-channel model is likely to give interesting answers, although the one-channel problem appears to have no self-consistent solution. (auth)

8164 A LEHMANN ELLIPSE FOR THREE-BODY COLLISION AMPLITUDES. G. Immirzi (Università, Rome). Nuovo Cimento (10), 34: 1361-70(Dec. 1, 1964).

The existence of an ellipse of analyticity in the complex plane of the cosine of the scattering angle is derived for the amplitudes of scattering on a bound state, including elastic as well as inelastic and rearrangement scattering, the only condition being that in the initial and in the final state there is a free particle and a bound state of the other two. The possibilities of extending this result to a complete analysis of the analytical properties of the amplitudes in the momentum-transfer variable are briefly discussed. Yukawian potentials and arbitrary masses are assumed throughout. (auth)

8165 SU_3 RELATIONS BETWEEN NEUTRINO PROCESSES. L. Maiani (Istituto Superiore di Sanità, Rome). Nuovo Cimento (10), 34: 1386-90(Dec. 1, 1964).

Relations between the amplitudes of processes $\nu(\bar{\nu})$ + $N \rightarrow \mu^-(\mu^+)$ + meson + baryon are studied in the unitary symmetry model for strongly interacting particles. Relations between processes with equal ΔS are derived. Tables are presented for the coefficients of the linear combinations of the reduced matrix elements which give the matrix elements of the processes considered, for any fixed ΔS. (M.J.T.)

8166 THE DEPOLARIZATION OF HIGH-ENERGY POSITRONS. W. Chinowsky, D. Cutts, and R. Stiening (Univ. of California, Berkeley). Nuovo Cimento (10), 34: 1431-45(Dec. 16, 1964).

The depolarization of high-energy positrons degraded to rest in matter was measured using the lifetime distribution of positronium in a magnetic field as a polarization analyzer. Positron beams with initial energies between 0.4 and 24 Mev were investigated. The use of a linear accelerator to produce a high-energy polarized positron beam is described. The results show that 12-Mev positrons are (79 ± 12)% depolarized in being degraded to rest. For this reason, the polarization analyzer using positronium in a magnetic field does not appear to be useful for high-energy applications. (auth)

8167 NOTE ON THE MAGNETIC MOMENTS OF BARYONS. J. J. Sakurai (Université de Paris, Orsay, France). Nuovo Cimento (10), 34: 1582-6(Dec. 16, 1964).

It is shown that the magnetic-moment relations of Coleman and Glashow are unaffected by ω-φ mixing and the ρ-φ mass difference, provided that the neutral vector mesons ρ^0, ω, and φ dominate the Pauli form factors of the baryons and that the coupling constants of the vector meson octet are given by unitary symmetry. (auth)

8168 SOME CONSEQUENCES OF THE OCTET DOMINANCE MODEL. A. H. Zimerman, Riazuddin, and S. Okubo.

(Univ. of Rochester, N. Y.). Nuovo Cimento (10), 34: 1587-95(Dec. 16, 1964). (UR-875-35)

Consequences of the octet dominance model based upon the tadpole diagram were investigated. Especially the decays $\omega \rightarrow 2\pi$, $K^+ \rightarrow 2\pi$, and the mass difference between K_1^0 and K_2^0 were computed. (auth)

8169 ON THE RADIATIVE CORRECTIONS TO THE MUON POLARIZATION FROM PION DECAY. E. S. Ginsberg and R. H. Pratt (Stanford Univ., Calif.). Nuovo Cimento (10), 34: 1633-7(Dec. 16, 1964).

It is noted that the polarization of muons (or electrons) from pion (or kaon) decay, $\pi(K) \rightarrow \mu(e) + \nu$, is not complete when radiative corrections are taken into account. It is shown that the correction is very small. (auth)

8170 REMARKS ON THE PHENOMENOLOGICAL ANALYSIS OF RESONANCES. J. D. Jackson (CERN, Geneva). Nuovo Cimento (10), 34: 1644-66(Dec. 16, 1964).

Some remarks are made concerning various aspects of the analysis of resonances produced in multi-particle final states resulting from high-energy collisions. The shape and position of a resonance are discussed by means of the connection between production cross sections for stable and unstable particles, and a numerical example of A^* as seen in $KA \rightarrow KA^*$ at different energies is given. The relation between the present description of the resonant effects and others (Watson's final-state interaction formula and the one-meson-exchange model of Chew and Low) is examined. Off-the-mass-shell corrections to the one-meson-exchange model are obtained in a relatively simple way. The bearing of the decay angular correlations on the production mechanism is explored; coordinate axes appropriate for the peripheral model are specified; the equivalence of the azimuthal angular distribution and the Treiman-Yang distribution is established. Angular correlations are given for the decay of boson resonances (J = 1,2) resulting from definite spin and parity states in the t-channel. Some remarks are made about the inclusion of nonresonant contributions when there is a mixture of pseudoscalar and vector exchange. (auth)

8171 SU_4 AND STRONG INTERACTIONS. D. Amati, H. Bacry, J. Nuyts, and J. Prentki (CERN, Geneva). Nuovo Cimento (10), 34: 1732-50(Dec. 16, 1964).

The group SU_4 is probably the most straightforward and economical generalization of SU_3 which allows for basic triplets of integral charges. The predictions of a few models for strong interactions based on SU_4 are analyzed. In addition to the usual (nonpeculiar) eightfold-way particles, new peculiar particles are predicted. However they can be allowed to be created and to decay semi-strongly by the mass-breaking interactions. Mass relations are obtained. It is pointed out that some difficulties concerning these mass formulas occur when one tries to attribute the ρ, K^*, ω, and φ vector mesons to the regular representation of SU_4. (auth)

8172 INELASTICITY AND PARTIAL-WAVE DISPERSION RELATIONS. E. J. Squires (Tait Inst. of Mathematical Physics, Edinburgh). Nuovo Cimento (10), 34: 1751-5(Dec. 16, 1964).

A problem consisting of two coupled channels is considered, and it is shown that the use of a one-channel N-over-D method, with the inelasticity introduced through the factor R in the unitary relation $\mathrm{Im}\, a = R|a|^2$, does not necessarily give the correct solution. (auth)

8173 DIRECT A-PRODUCTION IN K^--d REACTIONS. Ramesh Chand (Syracuse Univ., N. Y. and Wayne State Univ., Detroit). Nuovo Cimento (10), 34: 1796-1804(Dec. 16, 1964).

A previous investigation (Nuovo Cimento, 31: 1013(1964)) of the direct hyperon (Λ) production processes in the reactions $K^- + d \rightarrow \pi^- + \Lambda + p$ and $K^- + d \rightarrow \pi^0 + \Lambda + n$ is discussed. It is shown that the numerical results on the meson (π) momentum spectrum and the total rate for hyperon (Λ) production were in error, and correct numerical results are presented. (C.E.S.)

8174 POSSIBLE TEST OF THE BOOTSTRAP HYPOTHESIS. A. W. Martin (Stanford Univ., Calif.). Nuovo Cimento (10), 34: 1809-12(Dec. 16, 1964).

It is demonstrated that the spin-parity quantum numbers of the $Y_1^*(1405)$ resonance provide a test of the reciprocal bootstrap hypothesis. If the Y_1^* (1405) is a $p_{\frac{1}{2}}$ resonance, then the reciprocal bootstrap hypothesis must be either abandoned or substantially modified. (C.E.S.)

8175 ON THE HYPER-SUPERMULTIPLET SCHEME. W. M. Fairbairn (College of Science and Tech., Manchester, Eng.). Nuovo Cimento (10), 34: 1816-18(Dec. 16, 1964).

A previous suggestion that strongly interacting particles might be combined into hyper-supermultiplets by utilizing the "barbaryon" classification is discussed. Such multiplets were obtained by using the representations of the group $SU_3 \times SU_3$, which was suggested as a reasonable generalization of the Wigner supermultiplet scheme. The analogy between the two schemes is discussed, and the supermultiplet scheme is considered in more detail. (C.E.S.)

8176 A BREAKING OF THE SYSTEM OF FADDEEV'S INTEGRAL EQUATIONS FOR THE THREE-BODY PROBLEM. L. Bianchi and L. Favella (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 34: 1823-4(Dec. 16, 1964).

An attempt is made to show how the system of three coupled integral equations introduced by Faddeev for the three-body problem, by means of a simple transformation can be broken into two uncoupled integral equations which seem to be easier to solve than the previous system of three coupled equations of Faddeev. (C.E.S.)

8177 DYNAMICAL CONSIDERATIONS ON THE ISOSCALAR $\pi\rho$ RESONANCE (975 Mev). M. Suzuki (Tokyo Univ.). Nuovo Cimento (10), 34: 1829-31(Dec. 16, 1964).

It is shown that the isoscalar $\pi\rho$ (975) resonance recently observed should be assigned to the unitary singlet axial vector meson, 1^+ (1), on the basis of dynamical considerations with recourse to the SU_3 symmetry. (C.E.S.)

8178 RELATION BETWEEN TWO-BODY ANNIHILATION AND BACKWARD ELASTIC SCATTERING AT HIGH ENERGY. A. Bialas and O. Czyżewski (CERN, Geneva). Phys. Letters, 13: 337-9(Dec. 15, 1964).

It was previously shown that the analyticity of the scattering amplitude together with the assumption that the scattering amplitude does not oscillate at high energy (in the physical region) imply simple relations between the differential cross sections of crossed reactions in the high energy limit. The possibility of experimentally checking relations of this type is discussed. The backward elastic scattering of mesons (π) on protons, $p + \pi^+ \rightarrow \pi^+ + p$, and the annihilation of antiprotons into two mesons(π), $p + \bar{p} \rightarrow \pi^+ + \pi^-$, are considered. (C.E.S.)

8179 ON THE PRODUCTION OF $N^{*+}{}^{3}/_{2}{}^{3}/_{2}$ ISOBAR IN $\pi^+ p[\pi^+ p]$ INTERACTIONS AT 2.75 Gev/c. N. Armenise (Istituto di Fisica, Bari, Italy), B. Ghidini, S. Mongelli, A. Romano, P. Waloschek, J. Laberrigue-Frolow, Nguyen Huu Khanh, C. Ouannes, M. Sené, and L. Vigneron. Phys. Letters, 13: 341-3(Dec. 15, 1964).

A hydrogen bubble chamber was exposed to a 2.75-Bev/c meson (π^+) beam, and events corresponding to the reaction $\pi^+ p \rightarrow \pi^+ p \pi^0$ were found. Results on $N^{*+}{}^{3}/_{2}{}^{3}/_{2}$ production are discussed. The distribution of the four-momentum transfer to the isobar suggests a peripheral process for isobar production. Such a process is forbidden by meson(π) exchange for the reaction $\pi^+ p \rightarrow N^{*+}{}^{3}/_{2}{}^{3}/_{2}\, \pi^0$ but is allowed by single meson (ρ) exchange. The angular distributions in the isobar center of mass system show good agreement with theoretical predictions for a peripheral process with meson (ρ) exchange. (C.E.S.)

8180 COMPTON EFFECT ON MOVING ELECTRONS. O. F. Kulikov, Y. Y. Telnov, E. I. Filippov, and M. N. Yakimenko (Moscow State Univ.). Phys. Letters, 13: 344-6 (Dec. 15, 1964).

Compton scattering of laser photons of energy 1.79 ev by relativistic 550-Mev electrons during a head-on collision

of the beams was observed, and the experimental results are outlined. (C.E.S.)

8181 SU(6) AND CHARGE FORM FACTORS. J. M. Charap and P. T. Matthews (Imperial College of Science and Tech., London). Phys. Letters, 13: 346-7(Dec. 15, 1964).

It was previously suggested that in some approximation the strong interactions are invariant under the transformations of SU(6). It is shown that it is possible to deduce relations between charge form factors using a generalization of U-spin and that the electric charge form-factor of the neutron is zero. (C.E.S.)

8182 NOTE ON THE $\pi + N \rightarrow \eta + N$ REACTION NEAR THRESHOLD. S. Minami (Osaka City Univ.). Phys. Letters, 13: 353-4(Dec. 15, 1964).

Various possible explanations of the angular distribution for the $\pi + N \rightarrow \eta + N$ reaction near threshold are pointed out, and a method for experimentally determining a correct one among the possible explanations is suggested. (C.E.S.)

8183 CLASSICAL PHOTON BREMSSTRAHLUNG IN ELECTRON COLLISIONS. V. N. Bayer and V. M. Galitsky (Novosibirsk State Univ., U.S.S.R.). Phys. Letters, 13: 355-8(Dec. 15, 1964).

Cross sections for classical photon bremsstrahlung emission are derived for Coulomb scattering, electron-electron collisions, and electron-positron collisions. (C.E.S.)

8184 PHOTODISINTEGRATION OF THE TRITON WITH VELOCITY-DEPENDENT POTENTIALS. B. K. Srivastava (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 137: B71-4(Jan. 11, 1965).

The sum rules of Levinger and Bethe are used to calculate the integrated cross section (σ_{int}) and the bremsstrahlung-weighted cross section (σ_b) for the photodisintegration of the triton, using the wave function $\psi_0 = N\{\exp[-(\kappa/2)(r_{12} + r_{13} + r_{23})] + A \exp[-(\lambda/2)(r_{12} + r_{13} + r_{23})]\}$ and two-body velocity-dependent central potentials both for ^1S and ^3S states. The values of the wave-function parameters κ, A, and λ are those determined from a variational calculation of the binding energy of the triton. Our values of σ_{int} and σ_b agree reasonably well with those of Mathur et al. obtained by using hard-core wave functions and potentials, and also with the experimental values of Gorbunov et al. (auth)

8185 COHERENT π^0 PHOTOPRODUCTION FROM THE DEUTERON. M. Davier, D. Benaksas, D. Drickey, and P. Lehmann (Faculté des Sciences, Orsay, France). Phys. Rev., 137: B119-24(Jan. 11, 1965).

Coherent π^0 photoproduction from the deuteron has been measured at 180° pion angle for photon energies from 200 to 300 Mev by detecting momentum-analyzed recoil deuterons. The observed cross sections are compared with the results of the impulse-approximation calculation of Hadjioannou and show a large reduction of the cross section. Results of this and other experiments on coherent π^0 photoproduction have been compared to the theory: The impulse approximation seems most valid as transfer increases and for an incident photon energy between the first and second pion-nucleon resonances. A comparison with elastic pion-deuteron scattering is also performed in order to check the pion multiple-scattering corrections. (auth)

8186 PSEUDOSCALAR-MESON MASS DIFFERENCES IN A SELF-CONSISTENT MODEL. Richard H. Capps (Northwestern Univ., Evanston, Ill.). Phys. Rev., 137: B125-33(Jan. 11, 1965).

A bootstrap model of the P (pseudoscalar) and V (vector) meson octets is considered, in which the P and V are bound states or resonances in two-particle states of the type PV and PP, respectively. Unitary symmetry is assumed. Several approximations are made in the many-channel, partial-wave dispersion relations of the model, in order that simple self-consistency relations among the various P and V meson mass ratios may be obtained. If it is required that the P octet not be degenerate or nearly degenerate, near self-consistency can be obtained only if the pion mass is small compared to the K and η masses. It is argued that the SU_3 scheme of P, V, and baryon octets, and a $j^P = 3/2^+$ baryon decuplet, with mass splittings similar to those observed experimentally, is unusually well suited to a nondegenerate solution of a bootstrap model, because of the strong mutual coupling that exists among the lightest members of the various multiplets. (auth)

8187 SCHRÖDINGER BOOTSTRAP MODEL. William Ramsay and Max Luming (Univ. of California, San Diego, La Jolla). Phys. Rev., 137: B134-6(Jan. 11, 1965).

A Schrödinger-equation model for the process $K\bar{K} \rightarrow \varphi$ is solved numerically. The potential used is that given by one-φ exchange and an (SU_3-determined) one-ρ exchange. The coupling constant is fitted to give a resonance at the φ mass. The resulting cross-channel width is consistent with the direct-channel (Schrödinger) width. The discrepancy from the experimental width is similar to that present in S-matrix calculations. No cutoff is required. (auth)

8188 SOLUTION OF THE N/D EQUATIONS IN THE STRIP APPROXIMATION. Vigdor L. Teplitz (Univ. of California, Berkeley). Phys. Rev., 137: B136-9(Jan. 11, 1965). (UCRL-11555)

The solution to Chew's modified strip-approximation N/D equations is discussed. A Wiener-Hopf resolvent kernel appearing in the solution is evaluated explicitly. The solution to the N/D equation is studied as a function of the phase shift at the strip boundary. (auth)

8189 MORE ACCURATE TREATMENT OF THE LOW-ENERGY POTENTIAL IN THE STRIP APPROXIMATION. Geoffrey F. Chew and Vigdor L. Teplitz (Univ. of California, Berkeley). Phys. Rev., 137: B139-41(Jan. 11, 1965). (UCRL-11370)

Both the tractability and the reliability of the Reggeized strip approximation are increased by normalizing the long-range part of the potential at zero energy. The decomposition $V(t,s) = V(t,0) + V^R(t,s)$, where s is the energy squared and t is the negative square of momentum transfer, is made, and the first part V(t,0) is calculated from a low-t partial-wave expansion in the t reaction. $V^R(t,s)$, which vanishes at $s = 0$ but which dominates at large s, is calculated by the method of Chew and Jones from the leading crossed-reaction Regge trajectories. The normalization eliminates from the bootstrap calculation the need for accurate treatment of secondary trajectories that fail to reach $J = 0$; normalization, in fact, amounts to a sum over all poles, and is useful because poles that remain in the left half of the J plane may have an important influence on the low-energy potential while being negligible at higher energies. (auth)

8190 NUMERICAL SOLUTION OF THE PION-PION STRIP-APPROXIMATION N/D EQUATION. Doris C. Teplitz and Vigdor L. Teplitz. Phys. Rev., 137: B142-6 (Jan. 11, 1965).

Chew's strip-approximation N/D equations were solved numerically with a generalized potential of the form corresponding to elementary-particle ρ exchange plus the contribution from Pomeranchon exchange required by the fact that the phase shift at the strip boundary is generally nonzero. Trajectories and reduced residue functions are found. The trajectories have reasonable shapes, slopes in agreement with experiment [$\alpha' \approx 0.3/(\text{Bev}/c)^2$] for reasonably chosen strip widths, and end points in the region of $1 \gtrsim 0$. Increasing the phase shift at the strip boundary displaces trajectories upward, while increasing the strip width tends to flatten trajectories. The behavior of the reduced residues is found to be representable by a simple approximate formula in terms of the input potential. The potential investigated, with neglect of inelastic scattering, is incapable of generating a $J = 2$, $I = 0$ resonance and yields a ρ width several times too large. Increasing the phase shift at the strip boundary tends to improve the situation. (auth)

8191 IMPACT-PARAMETER EXPANSION OF HIGH-ENERGY ELASTIC-SCATTERING AMPLITUDES. W. N.

Cottingham and Ronald F. Peierls (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B147-54(Jan. 11, 1965). (BNL-8392)

An impact-parameter expansion of high-energy scattering amplitudes is formulated, and the unitarity condition at large but finite energies is discussed. Applications are then made to high-energy πp and pp elastic scattering with particular reference to the Van Hove model. This model is shown to give a good description of π^-p scattering at 17.0 Bev/c scattering momentum; the addition of a short-range real part gives a qualitative description of pp scattering at momenta between 12 and 20 Bev/c. (auth)

8192 FIELD-THEORETIC APPROACH TO THE ρ MESON. Moorad Alexanian (Indiana Univ., Bloomington) and Marcell Wellner. Phys. Rev., 137: B155-63(Jan. 11, 1965).

A previously discussed method is used to improve the Born series for the π-π scattering amplitude in the $\lambda\phi^4$ model. Only the first two nonvanishing Born terms are considered in each instance: to order λ^2 for isospin 0 and 2, and to order λ^3 for isospin 1. The results may be interpreted in terms of the existence of an isospin-one P-wave resonance. Its position is adjusted to fit experiment, thereby determining all other parameters in the theory. Taking the pion mass as a unit, we find the energy width of the resonance to be $\Gamma = 0.72$. The scattering lengths a_I^J come out as $a_0^0 = -0.78$, $a_1^1 = +0.032$, $a_2^0 = -0.44$. The coupling constant, as defined by Chew and Mandelstam, is $\lambda = +0.24$. All these values are rather insensitive to the position of the resonance. The numerical calculations may be done by hand. (auth)

8193 PRODUCTION OF W MESONS IN $N\bar{N}$ ANNIHILATION. R. R. Lewis, Jr. (Argonne National Lab., Ill.). Phys. Rev., 137: B164-7(Jan. 11, 1965).

The consequences of assuming the existence of intermediate W mesons with mass greater than two nucleons are examined. Nucleon-antinucleon annihilation would then be an alternative to neutrino interactions as a production mechanism. The production cross section would show a resonance with natural width $\Gamma \geq 50$ kev and integrated area $\int \sigma dE \sim 30\mu$b Mev. The characteristic features of this production amplitude are presented, together with a summary of results for the two-body decay modes. The problem of locating this resonance in counter and bubble chamber experiments is discussed. (auth)

8194 $\pi\pi$-$K\bar{K}$ MODEL OF THE ρ MESON. Louis A. P. Balázs (California Inst. of Tech., Pasadena). Phys. Rev., 137: B168-71(Jan. 11, 1965).

The parameters of the ρ meson are calculated in the coupled $\pi\pi$-$K\bar{K}$ problem, using a simple version of the strip approximation. Experimental values are taken for the π, K, K^*, and ϕ masses, while all the coupling constants are assumed to be related through SU(3). The width of the ρ turns out to be 360 Mev, while the mass is 765 Mev. Possible corrections to the model are discussed. (auth)

8195 SOLUTION OF A p-WAVE EQUATION FOR PION-PION SCATTERING. J. Franklin, D. J. Land, and R. Piñon (Brown Univ., Providence). Phys. Rev., 137: B172-7(Jan. 11, 1965).

A fixed-momentum-transfer dispersion relation is used in a self-consistent calculation of the ρ meson. An expansion of the scattering amplitude in terms of a new variable, introduced by a conformal transformation, forms the starting point of the present calculation, and this expansion converges throughout the physical region. A self-consistent p-wave resonance is found at 340 Mev. It is concluded that the ρ meson is not capable of producing itself self-consistently and that some other mechanism is responsible for the 750-Mev p-wave resonance observed in the π-π system. (auth)

8196 ASYMPTOTIC DECREASE OF SCATTERING AMPLITUDES. A. P. Balachandran (Univ. of Chicago). Phys. Rev., 137: B177-80(Jan. 11, 1965).

A recent analysis of the large-angle p-p scattering data at high energies indicates that the scattering amplitude outside the diffraction peak falls off asymptotically like $\exp[-c(\theta)s^{\frac{1}{2}}]$ for fixed angles, where $c(\theta)$ is some function of the center-of-mass scattering angle θ and s is the square of the center-of-mass energy. It is shown that if the scattering amplitude is $O\{\exp[-c(\theta)s^{\frac{1}{2}}]\}$ as $s \to \infty$ where $c(\theta) > 0$ for some fixed θ, then the entire scattering amplitude for this θ is uniquely determined by the function associated with the left-hand cut in the fixed-angle dispersion relation. The spectral function for the right-hand cut is exhibited as the Fourier transform of an analytic function which is defined by a power series in a certain domain of its regularity. The power series involves only quantities which are determined by the left-hand cut. Unitarity is not explicitly used in the proof, so that this asymptotic requirement plus the nature of the left-hand cut must imply the unitarity condition and hence the mass spectrum in the s channel at all energies. If the scattering amplitude is $O\{\exp[-c(\theta)s^{\frac{1}{2}}]\}$ where $c(\theta) > 0$ for a nonzero interval in θ, then the amplitude is uniquely determined by its left-hand cut for all θ by analytic continuation. In this case, the solutions of the partial-wave dispersion relations are also unique. (auth)

8197 X-RAY WAVELENGTH CONVERSION FACTOR $\Lambda(\lambda g/\lambda s)$. J. A. Bearden (Johns Hopkins Univ., Baltimore). Phys. Rev., 137: B181-7(Jan. 11, 1965).

A new experimental value of the x-ray conversion factor Λ (mÅ/xu) was obtained through a precision experiment on calcite crystals, and a recommended value of Λ was adopted based on this and other data. Nine selected crystals were used and the principal impurities were determined by spectrochemical analysis. Grating constants were measured with the Cu $K\alpha_1$ and Ag $K\alpha_1$ emission lines, and the density of each crystal was obtained by hydrostatic weighing in ethylene bromide. The product $\rho d'^3$ for an ideal impurity-free crystal was then computed by a linear extrapolation, with a least-squares adjustment to determine coefficients. The geometrical volume factor Φ was found by experimental measurement of dihedral angles on five of the crystals. Combining these data with the best available values for atomic weight and Avogadro's number yields $N\Lambda^3 = (6.05972 \pm 0.00015) \times 10^{23}$ (g mole)$^{-1}$ (mÅ/xu)^3 and $\Lambda = 1.002055$ mÅ/xu, where the x unit is based on $\lambda_{Cu\ K\alpha_1} = 1537.400$ xu. Taking a weighted average of this result and other high-precision data on Λ led to the adoption of $\Lambda = (1.002056 \pm 0.000005)$ mÅ/xu expressed on the same basis. The result is $\Lambda = (1.002076 \pm 0.000005)$ mÅ/xu when referred to an x-unit scale on which $\lambda_{W\ K\alpha_1} = 208.5770$ xu. This last wavelength then is $\lambda_{W\ K\alpha_1} = 0.2090100$ Å, which was adopted as a wavelength standard. (auth)

8198 NUMERICAL SOLUTION OF FIXED-SOURCE FIELD THEORIES. Charles Schwartz (Univ. of California, Berkeley). Phys. Rev., 137: B212-18(Jan. 11, 1965).

A modification of the Tamm-Dancoff method for fixed-source meson theories is set up for automatic computation. The Chew (1954) model of pion-nucleon interactions is calculated with up to six virtual mesons. Bound-state parameters and scattering phase shifts are obtained, accurate to about 1%, at a cost of about 3 min of computer time each. (auth)

8199 RESTRICTED $\Delta Q/\Delta S = -1$ WEAK CURRENTS, CP, AND THE R(8) EXTENSION OF SU(3). Yuval Ne'eman (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 13: 769-71(Dec. 21, 1964).

The breakdown of CP invariance in K_2^0 decay previously explained within the framework of the current-current theory as a result of an out-of-phase $\Delta Q = -\Delta S$ current is discussed. It is shown that this result can be reconciled with the SU(3)-based description of the weak interaction including the Gell-Mann-Cabibbo version of universality of the weak vector current. This implies extending the parity-retaining symmetry into a badly broken R(8) system derived from the 8 representation of SU(3). Since R(8) starts at 8 and contains SU(3)/Z(3) but not SU(3), the picture would not allow for the existence of triplets (quarks, etc.). Thus if the breakdown of CP invariance is verified and no new

interactions be at work and provided the conventional weak hamiltonian is kept, one is led to definite conclusions with respect to the emergence of the eightfold way and the triality of its representations. (C.E.S.)

8200 INDEPENDENT CHARGE PARITIES. D. C. Peaslee (Australian National Univ., Canberra, Australia). Phys. Rev. Letters, 13: 771-3(Dec. 21, 1964).

It is proposed that one can anticipate the existence of two independent charge parities from the fact that any group sufficiently complex to describe the charge varieties of elementary particles, such as SU(3) or G_2, has at least two independent parameters. This statement is illustrated formally and is used to propose a selection rule for $n\pi$ decay of Y^* resonances. (C.E.S.)

8201 SU(6) AND WEAK INTERACTIONS. S. P. Rosen and S. Pakvasa (Purdue Univ., Lafayette, Ind.). Phys. Rev. Letters, 13: 773-6(Dec. 21, 1964).

Weak interactions are examined in the light of SU(6). The transformation properties of the weak hamiltonian are considered. Leptonic and nonleptonic hyperon decay is discussed. (C.E.S.)

8202 BOOTSTRAP THEORY AND THE PARITY-NONCONSERVING DECAYS OF THE HYPERONS. R. F. Dashen (California Inst. of Tech., Pasadena), S. C. Frautschi, and D. H. Sharp. Phys. Rev. Letters, 13: 777-80 (Dec. 21, 1964).

A previously proposed general bootstrap theory of octet enhancement in the strong, electromagnetic, and (parity-conserving) weak violations of SU(3) symmetry is applied to the problem of parity-nonconserving weak interactions. The particular case considered is nonleptonic hyperon decay. (C.E.S.)

8203 Y = 2 STATES IN SU(6) THEORY. Freeman J. Dyson and Nguyen-huu Xuong (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 13: 815-17(Dec. 18, 1964).

The classification of two-baryon, one-baryon, and zero-baryon states with hyperchange Y = 2 in the SU(6) theory of strongly interacting particles is discussed. (C.E.S.)

8204 THE SEARCH FOR S-MATRIX AXIOMS. Geoffrey F. Chew (Univ. of California, Berkeley). Physics, 1: 77-83(Sept.-Oct. 1964). (UCRL-11414)

Recent efforts to find a complete set of S-matrix axioms are reviewed, emphasis being placed on the impossibility of fitting electromagnetism into the existing framework. It is suggested that a pure S-matrix theory may describe an artificial but recognizable world containing all strongly interacting particles but no photons or leptons. The theory would not be self-sufficient because of its failure to provide a mechanism for the measurement of particle momenta (i.e., for experiments that give a meaning to macroscopic space-time), and therein would lie the necessity for electromagnetism. From this viewpoint, the photon mass and the fine structure constant are linked to the theory of measurement and do not emerge from the dynamical bootstrap that determines the strong interaction parameters. (auth)

8205 NOTE ON BOSON RESONANCES. D. C. Peaslee (Australian National Univ., Canberra). Physics, 1: 85-90 (Sept.-Oct. 1964).

A simple model for boson resonances in terms of spin-½ baryon-antibaryon pairs is in striking qualitative accord with current data and may merit further pursuit. An empirical test is available, since the model anticipates five sets of positive parity resonances in the region $\gtrsim 1$ Bev, with spins 2, 1, and 0. A complication implied by the model is the presence of other symmetry clashes besides those including SU_3, in order to interpret the 1^- mass values and their correlation with charge parity. (auth)

8206 THE "ρ-EXCHANGE" MODEL FOR THE REACTION $\pi + N \rightarrow N^* + \omega$. Takao Narita and Takeshi Ebata (Tohoku Univ., Sendai and Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 598-605(Oct. 1964).

The reaction $\pi + N \rightarrow N^* + \omega$ is analyzed in terms of the ρ-exchange model, which is shown to be quite successful in other reactions. Contributions from the time-component, ρ-meson as well as recoil effect of nucleon are included. It is shown that the exchange of heavier systems other than the physical ρ-meson but with the same quantum numbers may be quite important to reproduce a forward peak of the produced ω. The magnitude of the 3π-ω interaction is estimated roughly also. (auth)

8207 POLE APPROXIMATION AND UNITARY SYMMETRY IN NONLEPTONIC HYPERON DECAYS. Chiaki Itoh and Azuma Toda (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 606-18(Oct. 1964).

The decay rates and the asymmetry parameters α of nonleptonic hyperon decays were evaluated assuming the unitary symmetry scheme and the predominance of 1-, 8-, 10-, 10^*-, and 27-dimensional baryon and boson poles. In RP invariant case, a relation $A_\Lambda = \sqrt{3}\, A_0$ can be obtained if 10 dimensional scalar boson term is absent. From this relation together with $\alpha_0 = -1$ and $\alpha_+ = \alpha_- = 0$, the model gives the following satisfactory results: $\tau_{\Sigma^-} = 1.6 \times 10^{-10}$ sec, $\tau_{\Xi^-} = 2.0 \times 10^{-10}$ sec, $\alpha_\Lambda = 0.48$, $\alpha_{\Xi^-} = -0.55$, $\gamma_\Lambda > 0$, and $\gamma_{\Xi^-} > 0$, where the value of $\tau_\Lambda = 2.5 \times 10^{-10}$ sec is used. The non-RP invariant case was discussed, and the two examples of solutions which are roughly consistent with the experimental data are presented. The present status of the experimental data seems to be still too uncertain to get a definite answer to the validity of RP invariance. (auth)

8208 A COMMENT ON THE NONLEPTONIC WEAK CURRENT AND BARYON-LEPTON SYMMETRY. Ken-iti Matumoto (Kyoto Univ.), Masami Nakagawa, and Yoshio Ohnuki. Progr. Theoret. Phys. (Kyoto), 32: 668-70 (Oct. 1964).

The $K \rightarrow 2\pi$ decay is discussed, and a modification of the nonleptonic weak current and baryon-lepton symmetry is presented. (C.E.S.)

8209 ON THE RESONANCE N^*_{11}. Noboru Hiroshige and Masayoshi Kikugawa (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 32: 670-1(Oct. 1964).

The resonance of mass 1400 Mev in the state of I = ½, $J^P = (1/2)^+$ of the πN system is discussed. An analysis of πN scattering, which strongly supports the existence of this resonance, is reported. (C.E.S.)

8210 GOLDBERGER-TREIMAN RELATION IN THE UNITARY SYMMETRY MODEL. S. Y. Tsai and Takesi Ogimoto (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 32: 673-4(Oct. 1964).

A revised expression of the Goldberger-Treiman relation is presented from the viewpoint of the unitary symmetry scheme for strongly interacting particles. The f/d ratio of the strong coupling constants are estimated from this relation, and these f/d ratios are compared with those obtained from other theories. (C.E.S.)

8211 PHOTOPRODUCTION OF NEUTRAL π-MESONS ON PROTONS AT 210 Mev. B. B. Govorkov, S. P. Denisov, A. I. Lebedev, E. V. Minarik, and S. P. Kharlamov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1199-1201(Oct. 1964). (In Russian)

Differential cross sections for the $\gamma + p \rightarrow p + \pi^0$ process are measured for six meson emission angles and photon energies $E_{\gamma lab} = 210 \pm 14$ Mev. Results of the measurements are compared with the cross sections calculated on basis of the dispersion relations. (auth)

8212 ELASTIC SCATTERING OF 650-Mev PROTONS. V. M. Guzhavin, G. K. Kliger, V. Z. Kolganov, et al. Zh. Eksperim. i Teor. Fiz., 47: 1228-31(Oct. 1964). (In Russian)

1767 elastic pp scattering events at an energy of 650 Mev were recorded in a liquid-hydrogen bubble chamber. The angular distribution of the scattered protons was obtained. (auth)

8213 MASS SPECTRUM OF CHARGED PARTICLES EMITTED IN THE ABSORPTION OF π^--MESONS BY PHOTOGRAPHIC EMULSIONS. A. O. Vaisenberg, E. D. Kolganova, and N. V. Rabin. Zh. Eksperim. i Teor. Fiz., 47: 1262-9(Oct. 1964). (In Russian)

The yield and spectrum of charged particles produced in photographic emulsion nuclear disintegrations induced by slow and fast (300 Mev) π^- mesons were studied. The yields of deuterons and tritium nuclei with energies ≥10 Mev from light nuclei (C, N, O) disintegrated by slow π^- mesons (σ_π stars) are, respectively, approximately 40 and 15%. The yields of deuterons with energies ≥20 Mev from heavy nuclei (Ag,Br) is close to 40% and is small for energies <20 Mev. Absorption of fast π^- mesons does not result in appreciable emission of complex particles. (auth)

8214 A STATISTICAL ANALYSIS OF THE ANGULAR DISTRIBUTION OF SHOWER PARTICLES. G. M. Chernov and V. M. Chudakov (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Zh. Eksperim. i Teor. Fiz., 47: 1273-8(Oct. 1964). (In Russian)

Statistical methods are proposed for quantitative verification of various models of multiple production of particles in high-energy NN collisions. The angular distribution of secondary shower particles produced in photographic emulsions by nucleons with energies above 10^{12} ev is compared with the predictions of the usual double-center model and the Hasegawa multi-center model. (auth)

8215 PRODUCTION OF PROTON-ANTIPROTON PAIRS IN HEAD-ON ELECTRON-POSITRON BEAMS. F. S. Sadykhov, I. G. Dzhafarov, and R. Sh. Yakh'yaev (Inst. of Physics, Academy of Sciences, Azerbaidzhan SSR). Zh. Eksperim. i Teor. Fiz., 47: 1463-7(Oct. 1964). (In Russian)

The production of longitudinally polarized proton-antiproton pairs in collisions between polarized electron and positron beams is considered by taking into account the form factors of all participating particles. Expressions are obtained for the angular and energy distributions of the pairs produced. The formulas are being used for analysis of the influence of form factors and spin states of particles on the angular and energy distribution of the process. Expressions are derived which yield the angular and energy dependences of the degree of longitudinal polarization of the proton-antiproton pairs produced. (auth)

8216 ON SOME PROCESSES INVOLVING HIGH ENERGY POLARIZED ELECTRONS AND POSITRONS. Yu. G. Shakhnazaryan (State Committee on Utilization of Atomic Energy, Inst. of Physics, Erivan). Zh. Eksperim. i Teor. Fiz., 47: 1503-8(Oct. 1964). (In Russian)

The cross sections for some processes involving longitudinally polarized electrons and positrons of high energy are calculated by the two-component spinor formalism under an assumption regarding the distribution of charge and magnetic moment of the particles involved in the process. (auth)

8217 LEPTONIC LAMBDA DECAYS: THEIR BRANCHING RATIOS AND THE SPACE-TIME PROPERTIES OF THEIR INTERACTION CURRENTS. Vance Gordon Lind. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 99p.

Twenty-one lambda beta decays were observed from $K^0\Lambda^0$ production in hydrogen, for which the lambdas are highly polarized, and three events from $K^0\Sigma^0$ production. The 21 polarized events plus one polarized event from an earlier experiment were studied as to the space-time properties of the interaction currents. Assuming vector and axial vector currents, a likelihood fit to the data gave a best value for the ratio of the coupling strengths of $k = C_A/C_V = -1.03$. The average weighted polarization of the lambdas used was $P = -0.91 \pm 0.10$. $C_A = 0$ and $C_V = +C_A$ are ruled out by $4 \times 10^5/1$ and $6 \times 10^4/1$ odds against them respectively. Also $C_V = 0$ is less likely than $C_V = -C_A$ by 38/1 odds. Higher order terms as a result of induced effects are investigated, but the statistical errors are too large to permit anything of significance to be said. The branching ratios of the leptonic events to the normal (pionic) decays for this experiment are $R_e = (1.55 \pm .34) \times 10^{-3}$ and $R_\mu = (1.3 \text{ to } 6.0) \times 10^{-4}$. ($R_\mu$ is based on two unambiguous Λ_μ decays and seven events which are also consistent with $\Lambda \rightarrow p + \pi^-$ followed immediately by $\pi^- \rightarrow \mu^- + \bar{\nu}$.) For muon-electron universality and V-A we expect $R_e/R_\mu = 5.3$ which is consistent with the obtained value. The results for R_e and k are compared to the predictions of a theory of weak interactions by Nicola Cabibbo and are found to be in excellent agreement. (Dissertation Abstr., 25: No. 2(Aug. 1964))

8218 DIFFERENTIAL CROSS SECTIONS FOR PHOTOPRODUCING POSITIVE Pi MESONS FROM HYDROGEN AT ENERGIES NEAR THE FIRST RESONANCE. Raymond Angelo Alvarez, Jr. Thesis, Stanford, Calif., Stanford Univ., 1964. 294p.

Angular distributions for the process $\gamma + p \rightarrow \pi^+ + n$ were measured for the center of mass range extending from about 40° to 140° at photon energies of approximately 225, 250, 275, 300, and 350 Mev. These measurements were normalized to an absolute cross section measured at k = 309 Mev and $\theta^* = 108°$. The overall accuracy of the absolute normalization is about 5½% while the systematic errors on the angular distributions range from about 5% at 300 Mev to about 10% at 225 Mev. The statistical errors on the angular distributions are typically one percent. The results are compared with those of previous experiments as well as with theoretical predictions based on the theories of Chew, Goldberger, Low, and Nambu and of McKinley. The present results are essentially in agreement with other measurements at the lower energies. However in the region around 300 Mev they are generally larger than all the others except for the Bonn "magnet" data. The agreement with the CGLN theoretical predictions calculated by Robinson (with effective range phase shifts) is quite good, and is clearly better than one obtains with the McKinley theory or with the CGLN theory with experimental P-wave phase shifts. The inclusion of a negative $\gamma\pi\rho$ coupling constant in the McKinley theory possibly improves the shape of the angular distributions, but it tends to make the absolute theoretical cross sections fall too low. A positive coupling constant leads to much poorer agreement with the data at the larger angles. (Dissertation Abstr., 25: No. 2(Aug. 1964))

8219 AN ELECTRON SCATTERING INVESTIGATION OF THE STRUCTURE OF THE BOUND PROTON IN THE DEUTERON. Donald Watt Aitken, Jr. Thesis, Stanford, Calif., Stanford Univ., 1964. 192p.

An electron scattering investigation with the Stanford Linear Accelerator was undertaken to determine the structure of the bound proton in the deuteron. In order to proceed with the bound proton investigation, it is necessary to determine the magnitude of the form factors for the free proton under the same operating conditions that are employed for the bound configuration. The results for a momentum transfer corresponding to $q^2 = 6.8\ F^{-2}$ are $G_M = 1.483 \pm 1.9\%$, and $G_E = 0.534 \pm 3.8\%$, resulting in the values $F_1 = 0.601 \pm 3.3\%$ and $F_2 = 0.492 \pm 5.8\%$ for the free proton form factors. The ratio G_M/G_E yields 2.78, in good agreement with observations by other workers in the electron scattering field. The results of the electron-proton coincidence detection investigation from the deuteron demonstrate no significant differences in form factors from those of the free proton. No final state interaction effects are observed in the angular distribution of recoiling protons within the statistics of the experimental investigation. It is further demonstrated that different forms for the neutron-proton potential energy function cannot produce appreciable differences within the statistics of this experiment. The shift in peak energy of the spectra for different points on the angular distribution of recoiling protons is shown to be consistent with initial proton momenta to be expected from binding effects. (Dissertation Abstr., 25: No. 2(Aug. 1964))

8220 LAMBDA-NUCLEON INTERACTIONS AT LOW AND INTERMEDIATE ENERGIES. Budh Ram. Thesis, Boulder, Colo., Univ. of Colorado, 1963. 69p.

A form of the lambda-nucleon interaction potential having a hard core and an attractive well characterized by four parameters is suggested. Two of these parameters char-

acterize the region of large separations, the range parameter being selected by consideration of the two-pion-exchange mechanism, and the other two parameters characterize the region of small separations outside the hard core. Eight potentials of this form having the same value of the hard-core radius but different values of the parameters characterizing the attractive well are constructed. All the eight potentials are consistent with the binding energy data for the light hypernuclei. These potentials are used to calculate the binding energy of a lambda particle in nuclear matter by the independent-pair approximation. The results of these calculations give a value for the binding energy of a lambda particle in nuclear matter of about 40 Mev. This value is compared with the currently preferred empirical value of 30 Mev. The lambda-nucleon total and differential cross sections are also calculated by the method of partial waves, with and without suppressing the interaction in odd partial waves. Our calculated cross sections are of the same order of magnitude as experimentally observed cross sections reported by Alexander, et al. but are much smaller than those reported by Arbuzov, et al. Comparison of the cross sections obtained by the suppression of the interaction in odd partial waves with those reported by Alexander, et al. leads to the conclusion that if their cross sections turn out to be correct, the estimate of the binding energy of lambda particles in nuclear matter may be closer to 40 Mev than to 30 Mev. (Dissertation Abstr., 25: No. 2(Aug. 1964))

8221 SOME ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES. Robert Lyman Zimmerman. Thesis, Seattle, Univ. of Washington, 1963. 93p.

The positions of the singularities of the partial wave amplitude in the complex λ plane are investigated for the case of a relativistic two-particle elastic scattering amplitude satisfying the Mandelstam representation. For a finite number of intermediate states it is shown that the convex hull of singularities of the partial wave amplitude in the complex λ plane is related to a growth indicator function. For an infinite number of intermediate states it is demonstrated that there exist singularities extending to infinity parallel to the imaginary axis in both directions. The elastic scattering amplitude for neutral pseudoscalar particles is calculated in the limit of high energies and small momentum transfer. All inelastic channels in the intermediate state are kept and only two particles are exchanged. The resulting expression gives the upper and lower bounds of the total cross section $b/s < \sigma(s)\ a/s^{\epsilon}$ where $\epsilon > 0$ and a,b are real constants. A special case of this elastic scattering amplitude is shown to be of the form suggested on the basis of the Regge theory of complex angular momentum. If the slope of the Regge trajectory is taken to be $a \simeq 1/50$ we obtain a total cross section that decreases very slowly $\sigma(s) = (k/16\pi)\ s^{-.005}$ where k is some real constant. (Dissertation Abstr., 25: No. 2(Aug. 1964))

8222 WEAK INTERACTIONS AND TOPICS IN DISPERSION PHYSICS. Lecture Notes from the Second Bergen International School of Physics–1962. Christian Fronsdal, ed. New York, W. A. Benjamin, Inc., 1963. 340p. $9.00 (cloth edition); $4.95 (paperback).

Nineteen lectures are presented on weak interactions and topics in dispersion physics. Separate abstracts have been prepared for each. (L.B.S.)

For abstracts of individual lectures see: 8223, 8224, 8225, 8226, 8227, 8228, 8229, 8230, 8231, 8232, 8233, 8234, 8235, 8236, 8237, 8238, 8239, 8311, and 8492.

8223 INTRODUCTION TO BETA DECAY. G. Bernardini (CERN, Geneva). p.1–15 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The significance of experiments on weak interactions, which gives supplementary support to the V-A theory, is discussed. The principles and consequences of lepton conservation, Fermi and Gamow-Teller transitions, and Fermi interactions are also discussed. (L.B.S.)

8224 HYPERFINE EFFECTS IN MUON CAPTURE. V. L. Telegdi (Univ. of Chicago). p.16-25 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Experimental evidence on the nature of $(NP)(\nu_\mu)$ coupling in complex nuclei is reviewed. Arguments are presented of the presence of V coupling in relation to the hyperfine effects. Other hyperfine experiments are mentioned: capture of μ by a $j = 1 - \frac{1}{2}$, $d_{\frac{5}{2}}$ proton; capture by ^{11}B; and inner bremsstrahlung in μ^- capture. (L.B.S.)

8225 TOPICS IN DISPERSION PHENOMENOLOGY. S. Fubini (Universitá, Turin). p.38-49 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The physical principles and limitations involved in the application of the dispersion method to problems in elementary particle physics are presented. The substitution rule, s-matrix poles, and the effects due to the presence of unstable particles in intermediate states are discussed, and examples of pion-nucleon and electron-nucleon scattering are given to illustrate these principles. (L.B.S.)

8226 STRUCTURE OF WEAK INTERACTIONS. S. B. Treiman (Princeton Univ., N. J.). p.50-109 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

An analysis of weak decay interactions was made and evidence was found for the two-component theory of the neutrino, lepton conservation, electron-muon universality, the V-A nature of leptonic couplings; identity of the μ decay coupling constant and the beta decay effective vector coupling constant, the $|\Delta I| = \frac{1}{2}$ rule for weak non-leptonic interactions, and time reversal invariance. Conjectures are made on the structure of weak non-leptonic interactions, the intermediate boson hypothesis, and the two neutrino hypothesis. High energy neutron absorption is investigated, and the problems of beta decay and pion decay form factors are considered. (L.B.S.)

8227 ISOTOPIC SPIN STRUCTURES OF THE WEAK INTERACTIONS. R. E. Behrends (Yeshiva Univ., New York) and A. Sirlin. p.110-21 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A phenomenological analysis of weak interactions is made assuming axial vector space-time properties, a two-component neutrino, and conservation of isotopic spin, hypercharge, and parity in strong interactions. The Lagrangians for weak processes involving only leptons, both leptons and strongly interacting particles, and only strongly interacting particles are investigated. Isotopic spin, hypercharge, and parity analysis of the Lorentz covariants for strongly interacting particles is made. The currents leading to charged leptonic transitions are tabulated and classified according to strangeness and isotopic spin properties, and evidence for the existence or absence of these currents is presented. A general scheme for the weak interaction Lagrangian is developed, and the general features leading to experimental predictions are listed. It is emphasized that in weak interactions of neutrino beams, these features lead to many relations between the various amplitudes. (L.B.S.)

8228 FORBIDDEN PROCESSES IN WEAK INTERACTIONS. L. di Lella (CERN, Geneva). p.122-7 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The possible existence of mechanisms capable of giving rise to $\mu^+ \to e^+ + \gamma$, $\mu^+ \to e^+ + e^+ + e^-$, $\mu^- + z \to z + e^-$ reactions at a rate experimentally accessible is discussed, assuming no new selection rule. It is then shown that the lack of observation of these reactions strongly favors the two neutrino hypothesis. (L.B.S.)

8229 MUON CAPTURE IN HYDROGEN. H. Primakoff (Univ. of Pennsylvania, Philadelphia). p.128-39 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The quantitative theory of muon capture by a proton was investigated and the capture rate in $[p\mu^- p]\gamma$ was calculated, where $[p\bar{\mu}p]\gamma$ refers to the predominant formation of the $[p\mu^- p]$ molecule (ion) in an effectively stable 1s ortho con-

figuration. The transition matrix element for muon capture by protons was developed, and the character of the nucleon states was determined. Dispersion-theoretical representations for the form factors were constructed, and explicit expressions for dispersion relation integrals were obtained from empirical data for electron scattering form factors. The muon capture rate, 560 sec^{-1}, was found to be in rough agreement with experimental values. (L.B.S.)

8230 WEAK INTERACTION FORM FACTORS IN $\Sigma \rightarrow \Lambda + e + \nu$. H. Primakoff (Univ. of Pennsylvania, Philadelphia). p.140-3 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The treatment of weak interaction form factors is extended to the $\Sigma \rightarrow \Lambda + e + \nu$ decays, which involve strangeness-conserving transitions between states with nonvanishing strangeness. An approximate expression for the transition matrix element that contains the weak-magnetism ($\sqrt{2}\mu$) and axial-vector (g_A) coupling constants is obtained. The magnetic form factor was found to be approximately 1.85, and the Σ^0 lifetime $1/\tau_{\Sigma^0}$ was estimated at 2×10^{19} sec^{-1}. A relation was established between the rate [$\Sigma^- \rightarrow \Lambda + e^- + \nu$] and the Σ^0 lifetime, and the branching ratio for R[$\Sigma^- \rightarrow \Lambda + e^- + \nu$] relative to R[$\Sigma^- \rightarrow n + \pi^-$] was obtained for $g_A \simeq 1$, predicted by Goldberg-Treiman relations, and $g_A = 0.2$, conjectured on the basis of the Sakata model. (L.B.S.)

8231 WEAK INTERACTION FORM FACTORS IN $K \rightarrow \pi + (e \text{ OR } \mu) + \nu$. H. Primakoff (Univ. of Pennsylvania, Philadelphia). p.144-51 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A dispersion-theoretic approach was used in an analysis of the weak interaction form factors in $K \rightarrow \pi + \mu + \nu$ and $K \rightarrow \pi + e + \nu$ decays. Dispersion relations were obtained, and the Goldberg-Treiman type relation was derived using empirical information regarding resonant states of the $K\pi$ system. The branching ratio for $(K^- \rightarrow \pi^0 + \mu^+ + \nu)/(K^+ \rightarrow \pi^0 + e^+ + \nu)$ was found to be approximately 0.66, which was compared with the experimental value of 1.0 ± 0.2. The relation between the processes, $K^+ \rightarrow \pi^0 + e^+ + \nu$ and $K_2^0 \rightarrow \pi^- + e^+ + \nu$, is discussed. (L.B.S.)

8232 REMARKS ON WEAK INTERACTION FORM FACTORS. A. Fujii (Frascati National Lab., Italy). p.152-60 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Some numerical estimates of the K_{l3} and hyperon beta decay rates, based on a specific model and the cross section for kaon production induced by high energy neutrinos, are reported. Comparison is made with experimental results. (L.B.S.)

8233 REGGE POLES AND NUCLEON FORM FACTORS. E. Predazzi (Universitá, Turin). p.161-72 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Nucleon form factors are defined using the matrix for e–N scattering and general principles such as Lorentz invariance and space-time inversion invariance. It is then shown that the Regge representation gives a more complete description of the electromagnetic form factors, which may account for effects which are not contained in a single resonance approximation. (L.B.S.)

8234 RADIATIVE CORRECTIONS TO FERMI INTERACTIONS. A. Sirlin (New York Univ., New York). p.173-84 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Results of application of the radiative corrections to polarize muon, pion, and neutron decay are summarized. Ambiguities in the corrections to neutron decay are discussed. (L.B.S.)

8235 QUANTIZATION, STATISTICS, AND ELEMENTARY PARTICLES. S. Kamefuchi (Imperial Coll. of Science and Tech., London). p.205-30 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A formalism for intermediate statistics for elementary particles is developed by generalizing the method of quantization in field theory statistics. Commutation relations are constructed assuming representations of the rotation or sympletic group with infinite dimensions. It is concluded that for the R-transformation, statistics can be obtained with the maximum occupation number $n_{max} = s - 1$, which can be any integer, whereas for the S-transformation, the n_{max} is always infinite as in the ordinary Bose-Einstein statistics. Degeneracy in many particle state vectors resulting from this generalization is discussed. It is found that the R-method and S-method can only be applied to spinor fields and tensor fields, respectively. Interactions between the quantized fields are discussed, and it is proved that a super-selection rule concerning the number of particles obeying the same kind of statistics exists. An attempt is then made to determine the statistics of all the known elementary particles. (L.B.S.)

8236 SINGULARITIES ON UNPHYSICAL RIEMANN SHEETS. P. G. O. Freund (Université, Geneva). p.231-40 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A study of the analytical properties of scattering and reaction amplitudes considered as functions of two complex invariant variables was made. The question is raised whether the analytic continuation of amplitudes around branching points into the unphysical sheets is possible. Assuming a Mandelstam representation, certain classes of singularities on the unphysical sheets are derived, some of which have physical consequences. (L.B.S.)

8237 NON-LANDAU SINGULARITIES IN PERTURBATION THEORY. Michael Fowler (St. John's Coll., Cambridge, Eng.). p.241-52 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Techniques for locating non-Landau singularities are discussed, and equations for non-Landau singularities are derived. Feynman integrals are examined, without the introduction of Feynman parameters. An example of mixed singularities generated from unitarity from a conjunction of non-Landau and Landau singularities is discussed in detail. The methods give a complete picture of the positions of the singularities, but it is not determined whether they are on the physical sheet. (L.B.S.)

8238 ON COMPLEX SINGULARITIES. Christian Fronsdal (Univ. of California, Los Angeles). p.253-68 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

The occurrence of complex singularities in amplitudes for processes involving only four particles is discussed. $\Sigma-\Sigma$ scattering is treated using a Feynman-Landau-Cutcosky diagram whose analytic properties are adequately represented by the Mandelstam representation. General methods of complex analysis are used to obtain the values of an analytic function in the domain of analyticity from knowledge of the residues of the poles and discontinuties across the branch cuts, using the Cauchy integral formula and the Bergman-Oka-Weil generalization as a basis. The question of whether the complexity of a singularity depends on the choice of variables is discussed. Spectral functions are calculated. (L.B.S.)

8239 DISPERSION RELATIONS IN STRONG-COUPLING PHYSICS. S. Mandelstam (Univ. of Birmingham, Eng.). p.269-332 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A survey is given of the principles underlying dispersion relations in elementary particle physics, and some of their phenomenological and dynamical applications are treated. The general nature of dispersion relations and their connection with causality are examined, with particular emphasis on the role recently played in strong-coupling physics. An account is given of the approximation scheme obtained by combining dispersion relations with unitarity, which provides a basis for calculations. Proved and conjectured dis-

persion relations are written and the plausibility of the conjectures is discussed. The calculations and results are summarized. (auth)

8240 THE γ SPECTRUM FROM MOLECULES WITH POSSIBLE ROTATIONS. H. Gerwin. Thesis, Cologne, Universität, 1963. 31p. $2.00(Gmelin, AED-DISS. 63-616). (In German)

The spectrum of γ quanta corresponding to excitation of rotations can be calculated for the case of a resting molecule. The distribution functions for some special cases are given. A sharp line with excitation energy can only be observed if the quotient of the square of the angular momentum and moment of inertia is small compared with the line width. This condition is satisfied for large enough crystals, so that the usual neglect of rotation energy for Mössbauer effect calculations is justified. An approximative solution for small angular momentum transfer is given. (Gmelin Inst.)

8241 RESONANCES IN LOW ENERGY $\pi\kappa$ SCATTERING. J. Bender. Thesis, Heidelberg, Universität, 1963. 40p. $2.00(Gmelin, AED-DISS. 63-689). (In German)

The $\pi\kappa$ resonances at 885 and 725 Mev were investigated theoretically. Location and width of the resonances were calculated using a self-consistent method neglecting inelastic processes. Conservation of strong interaction is explained by ρ meson exchange, which plays an important role in $\pi\kappa$ resonances. (Gmelin Inst.)

8242 APPLICATION OF DISPERSION RELATIONS TO PHOTOPRODUCTION. W. Schmidt. Thesis, Karlsruhe, Ger., Technische Hochschule, 1964. 44p. $2.00(Gmelin, AED-DISS. 64-37). (In German)

The photoproduction of a pion with a proton in the region of the first resonance was calculated. The real part of the production amplitude was taken from the dispersion relations for fixed momentum transmission. Results are compared with experimental data. (Gmelin Inst.)

8243 THEORY OF WEAK INTERACTIONS AT HIGH ENERGY. Gerald Feinberg (Columbia Univ.). p.277-375 of "Lectures on Astrophysics and Weak Interactions. Vol. 2." Waltham, Mass., Brandeis University, 1963.

Weak interactions of external particles at high energies (total kinetic energy ≳ 360 Mev) and the effect of virtual states of very high energy on the weak interactions at any external energy are considered. General properties of weak interactions, neutrino scattering experiments, phenomenological description of two-body neutrino reactions, isotopic-spin selection rules for neutrino reactions, properties and field theory of the intermediate vector meson (IVM), weak interactions in the lowest order and divergences in the IVM theory, the power counting method, peratization method and results for ladder graphs are discussed. (L.B.S.)

8244 LECTURES ON STRONG AND ELECTROMAGNETIC INTERACTIONS. Vol. 1 of the 1963 Brandeis Summer Institute Lectures in Theoretical Physics. P. T. Matthews, D. R. Yennie, and M. E. Mayer. Waltham, Mass., Brandeis University, 1963. 350p. $3.00

Three lectures on strong interactions of elementary particles, problems in quantum electrodynamics, and unitary symmetry of strong interactions are presented. Separate abstracts have been prepared for each. (L.B.S.)

For abstracts of individual lectures see: 8245, 8246, and 8312.

8245 STRONG INTERACTIONS OF ELEMENTARY PARTICLES. Paul T. Matthews (Imperial Coll. of Science and Tech., London). p.1-163 of "Lectures on Strong and Electromagnetic Interactions." Waltham, Mass., Brandeis University, 1963.

The main considerations on particles and interactions, the s-matrix, the substitution law, unitarity, analyticity (causality), invariance and conservation laws, spin angular momentum, and phase shifts used in analysis of strong interactions effects are discussed, and application is made to $\pi-N$ scattering, $\bar{K}-N$ scattering, resonances, and high energy scattering. (L.B.S.)

8246 UNITARY SYMMETRY OF STRONG INTERACTIONS. Meinhard E. Mayer (Brandeis Univ., Waltham, Mass.). p.259-341 of "Lectures on Strong and Electromagnetic Interactions." Waltham, Mass., Brandeis University, 1963.

A study was made of symmetries of particles, SU(3) and its representations, and the physics of SU(3). Known states of strongly interacting particles were classified into SU(3) supermultiplets; a baryon mass formula and relations between electromagnetic properties of baryons were derived; and relations between cross sections were predicted. (L.B.S.)

8247 THE RELATION BETWEEN BREMSSTRAHLUNG AND ELASTIC SCATTERING OF LOW ENERGY ELECTRONS. Raymond L. Taylor and Bennett Kivel (Avco Corp., Everett, Mass.). 26p. (CONF-364-10)

From 16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963.

A comparison is made between recent infrared measurements of bremsstrahlung in shock-heated air and nitrogen and elastic scattering cross sections for low energy electrons for molecular and atomic nitrogen and atomic oxygen. The bremsstrahlung intensity is analyzed by means of the Kramers-Unsöld expression to determine the effective coulombic charges, Z^2, for N_2, N, and O. The trend of the results is consistent with a similar trend for the elastic scattering cross sections of low energy electrons as determined from conductivity measurements in shock tubes and other measurements. This comparison suggests that the bremsstrahlung intensity is proportional to electron scattering. (auth)

Field Theory and Quantum Mechanics

8248 (JINR-E-1812) COMMUTATOR OF THE SCALAR FIELD IN THE TWO-DIMENSIONAL PSEUDO-RIEMANNIAN SPACE-TIME MODEL. N. A. Chernikov and E. Tagirov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p. Dep. (mn).

The Riemann method is used to get explicit expressions for the scalar field operator in an arbitrary two-dimensional pseudo-Riemannian space-time. The scalar field commutator is obtained by an immediate commutation of the field operators. (auth)

8249 (JINR-P-1784) O NELINEINYKH LAGRANZHIANAKH VZAIMODEISTRIYA. (On Non-Linear Interaction Lagrangians). G. V. Efimov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 15p. Dep.(mn).

The mechanism for removing ultraviolet divergences in local non-linear quantum field theory is investigated according to the scalar meson model in the field of the point fixed source. It is shown that the perturbation theory series as an expansion of the stationary states of the complete Hamiltonian in the stationary states of the free Hamiltonian are always divergent in the case of non-linear interactions. The functional methods by means of which it is possible to construct the finite S-matrix in the non-linear interaction Lagrangian are the summation methods of divergent series. The problem of uniqueness is still open even if unitarity and causality are fulfilled. (auth)

8250 (JINR-P-1815) PRIMENENIE METODA VKB PRI ASIMPTOTICHESKOM RESHENII URAVNENII. (The Application of WKB Method to the Asymptotic Solution of Equations). L. I. Ponomarev (Joint Inst. for Nuclear Research. Lab. of Theoretical Physics). 1964. 8p. Dep. (mn).

It is shown that the conventional method of reducing the Sturm-Liouville equation to the quasiclassical form leads to some difficulties, which do not appear if a particular

transformation is used. On the basis of this transformation, there were found quasiclassical asymptotics of the associated Legendre polynomials, spheroidal functions, and the wave functions of the two-center problems. The transformation is also of interest from a methodical point of view. (auth)

8251 (JINR-P-1826) K VOPROSY OB ABSOLYUTNYKH VELICHINAKH. (On Absolute Values). V. N. Strel'tsov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 6p. Dep.(mn).

A possibility is discussed of generalizing special relativity, if Planck's constant is taken into account. (auth)

8252 (LADC-6188) GALILEAN INVARIANCE AND GREEN'S FUNCTIONS FOR BOUND SYSTEMS. M. Bolsterli (Minnesota. Univ., Minneapolis. School of Physics and Los Alamos Scientific Lab., N. Mex.). [1963]. Contract W-7405-eng-36. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

It is shown that Galilean invariance leads to a natural definition of invariant Green's functions for bound systems. The spectral representation and differential equation for the single-particle Green's function are given. (auth)

8253 TIME-DILATATION DILEMMA AND SCALE VARIATION. M. Z. v. Krzywoblocki (Michigan State Univ., East Lansing). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2213-14(Dec. 1964).

It is concluded that under the assumption that the fundamental principles of the classical special theory of relativity are valid, if a clock D*, whose internal mechanism belongs to a Clausius family of systems, moves relatively to a clock D located on the earth with a velocity v and which is in some sort of a synchronization with D by means of only light signals, which do not affect the action or the rate of action of both clocks, then the (relativistic) unit of time of the clock D must be equal to the factor $(1-v^2/c^2)^{\frac{1}{2}}$ to be in a permanent synchronization with the clock D*. (C.E.S.)

8254 GAUGE INVARIANCE IN ASYMPTOTIC QUANTUM ELECTRODYNAMICS. Robert E. Pugh (Univ. of Toronto). Ann. Phys. (N. Y.), 30: 422-45(Dec. 1964).

Gauge invariance is investigated in asymptotic quantum electrodynamics. A condition on the S-matrix elements which is equivalent to Nishijima's generalization of the Ward identity is derived. It is shown that $\partial_\mu A_\mu = \partial_\mu A_\mu^{in}$, and the commutators of $\partial_\mu A_\mu$ with the interpolating fields are evaluated. Finally it is proven by induction in perturbation theory that the theory is automatically gauge invariant to all orders provided that the first order vertex function satisfies the above mentioned condition and that the higher order vertex functions satisfy boundary conditions derived from the requirement of gauge invariance. (auth)

8255 A UNIFIED TREATMENT OF INTEGRALS FOR ONE-ELECTRON OPERATORS. Serafin Fraga (Univ. of Alberta, Edmonton). Can. J. Chem., 42: 2509-13(Nov. 1964).

A general formula was developed to express, in terms of C-functions, the integrals appearing in the evaluation (when using Slater-type orbitals) of the expectation values of the most important one-electron operators. (auth)

8256 CAUSALITY REQUIREMENTS AND LINEAR FIELD EQUATIONS. T. F. Morris (McGill Univ., Montreal). Can. J. Phys., 42: 2080-5(Nov. 1964).

The requirements of Lorentz and time-reversal invariance, causality, positive definiteness of the field energy, and a boundedness condition on the propagator are used to determine the possible forms of linear field equations through the determination of their Green's functions in momentum space. The classical definition of causality, no output before input, is applied to a scalar field and is shown to imply the uniqueness of the usual propagator for a spin-zero particle of discrete mass. The classical definition of causality is then replaced by one appropriate for quantum theory. An additional type of equation is possible, which represents a particle with a continuous distribution of mass. (auth)

8257 QUANTUM AND CORRELATION CORRECTIONS TO THE THOMAS-FERMI POTENTIAL. K. S. Viswanathan and B. N. Narahari Achar (National Aeronautical Lab., Bangalore, India). Can. J. Phys., 42: 2332-44(Nov. 1964).

The correction to the Thomas-Fermi potential arising from the exchange, inhomogeneity, and correlation effects is studied. An alternative derivation of the Baraff equation is given, based on simple physical considerations. Starting from the Baraff equation and making use of the simple analytical formula of Tietz for the Thomas-Fermi potential, analytical expressions for the correction to the Thomas-Fermi potential are given within the radius of the atom applying the Gellmann-Brueckner high-density formula for the correlation energy of an electron gas and outside this range wherein the correlation energy can be approximated by the Wigner low-density formula. It is found that the main contribution to the solution of the Baraff equation arises from the inhomogeneity, screening, and the exchange terms. (auth)

8258 A MODIFICATION OF THE GEOMETRICAL OPTICS METHOD. Yu. A. Kravtsov (Radiotechnical Inst., Academy of Sciences, USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 664-73(1964). (In Russian)

The solution of a scalar wave equation can be specially fitted for the description of the field near the caustic, if the equation is written as a product of an exponential and Airy functions, the arguments of which are ψ_1 and ψ_2 correspondingly. In this case the problem is reduced to the solution of the eikonal equation for a certain function Ψ with ψ_1 and ψ_2 as its arguments. Consequently, the eikonal equation for function Ψ, coinciding with the wave phase only at a large distance from the caustic, is valid in all space including the caustic. (auth)

8259 ON THE THEORY OF COMBINATION RAMAN RADIATION IN STRONG FIELDS. Yu. G. Khronopulo (Gor'kii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 674-81(1964). (In Russian)

The kinetic equation for the density matrix, with the aid of an averaging method, is used to obtain approximate equations describing the processes of combination and double emission and absorption, taking into account the saturation effect. As an example, the case of the combination interaction of fields in a system with nonequidistant levels is considered. On the basis of the solutions obtained, the field values necessary for saturation in the case of magnetic and electric dipole interactions between matter and field are estimated. (auth)

8260 TWO-DIMENSIONAL SOLUTION OF A WAVE EQUATION FOR A LAYER WITH A NEGATIVE ABSORPTION COEFFICIENT AND TAKING INTO ACCOUNT THE SATURATION. T. I. Kouznetsova and S. G. Rautian (Lebedev Inst. of Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 682-92(1964). (In Russian)

A monochromatic stationary field is calculated within the layer of an active medium between plane parallel mirrors having arbitrary reflection coefficients. The field frequencies and fluxes emerging through the layer boundaries are determined. The results are compared with the theory based on radiation transfer equations. (auth)

8261 ELECTROMAGNETIC RADIATION IN THE PRESENCE OF MOVING SIMPLE MEDIA. K. S. H. Lee and C. H. Papas (California Inst. of Tech., Pasadena). J. Math. Phys. (N. Y.), 5: 1668-72(Dec. 1964).

The radiation pattern of an arbitrary source immersed in a moving simple medium is calculated by deducing the differential equation for the potential 4-vector in the rest frame of the source and then solving the equation in terms of a Green's function. As an illustrative example, the case where the source is an oscillating dipole is worked out in detail. (auth)

8262 REPRESENTATION OF FIELDS IN A TWO-DIMENSIONAL MODEL THEORY. Jan Tarski (New York

Univ., New York). J. Math Phys. (N. Y.), 5: 1713-22(Dec. 1964).

The two-dimensional model recently suggested by Schroer is examined. The free scalar massless field in two dimensions is discussed in detail. The infrared-myriotic representations of this field which arise in the model are described; it is shown that, up to unitary equivalence, the required representation depends only on the net total charge of the fermions. Discussion is also given of distribution-theoretic aspects of the fields, and in particular, of possible restrictions on test functions. (auth)

8263 ON THE REPRESENTATIONS OF THE SEMI-SIMPLE LIE GROUPS. III. THE EXPLICIT CONJUGATION OPERATION FOR SU_n. G. E. Baird and L. C. Biedenharn (Duke Univ., Durham, N. C.). J. Math. Phys. (N. Y.), 5: 1723-30(Dec. 1964).

The analog of the SU_2 (1 − j) symbol is defined and discussed for SU_n. An appropriate generalization to SU_n of the Condon–Shortley phase convection is explicitly given. (auth)

8264 ON THE REPRESENTATIONS OF THE SEMI-SIMPLE LIE GROUPS. IV. A CANONICAL CLASSIFICATION FOR TENSOR OPERATORS IN SU_3. G. E. Baird and L. C. Biedenharn (Duke Univ., Durham, N. C.). J. Math. Phys. (N. Y.), 5: 1730-47(Dec. 1964).

It is shown that the multiplicity structure of the general SU_n operators may be put in a one-to-one correspondence with the multiplicity structure of the corresponding states. This result allows a convenient labeling scheme to be devised for the general SU_n Wigner operator and leads in a natural way to the concept of a reduced Wigner operator. The problem of multiplicity in tensor operators is shown to have a canonical resolution in the conjugation classification which is discussed in detail for the SU_3 case. (auth)

8265 APPLICATIONS OF THE LORENTZ TRANSFORMATION PROPERTIES OF CANONICAL SPIN TENSORS. A. Chakrabarti (Université, Paris). J. Math. Phys. (N. Y.), 5: 1747-55(Dec. 1964).

Some applications of the Lorentz transformations of relativistic spin tensors in the canonical representation are discussed. The problem of precession of polarization is discussed in Sec. 2. It is shown that the kinematical equation, obtained quite simply, already contains the "Thomas factor." In Sec. 3, applications to polarization analysis of decay products are considered. The canonical form of S-matrix elements are used and multipole parameters for successive decays of the type $a \to b + c$ are obtained in an arbitrary frame in a relatively simple way. The exact relativistic way in which the multipole parameters depend, in an arbitrary frame, on the particle momenta are discussed for decays of the type $a \to b + c + d$. While the canonical representation is used mainly, the corresponding technique in the spinor representation is discussed. (auth)

8266 GENERALIZED PERTURBATION EXPANSION FOR THE KLEIN-GORDON EQUATION WITH A SMALL NONLINEARITY. David Montgomery (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 5: 1788-95(Dec. 1964).

A previously given method for deriving secularity-free perturbation expansions for the Klein-Gordon equation with a "small" nonlinear term is generalized to include situations in which the lowest-order solution is not restricted to be a monochromatic wave. (auth)

8267 THE ENIGMA $E = Mc^2$: POTENTIAL ENERGY AND RENORMALIZATION OF MASS. L. Brillouin. J. Phys. (Paris), 25: 883-6(Oct. 1964). (In French)

There is no energy without mass, but it seems that most authors simply ignored the case of potential energy. The founders of relativity theory keep silent about it. As a matter of fact, the corresponding energy is spread all around in space, and so is the mass. Symmetry properties of this distribution suggest splitting the mass equally between interacting particles. It is necessary to re-evaluate the values of masses, even in the classical theory of relativity, where this consideration was simply ignored. Renormalization is absolutely essential, before quantum theory, and must start at the beginning of Einstein's relativity. (auth)

8268 EQUIVALENCE OF THE SCHROEDINGER AND HEISENBERG PICTURES. P. A. M. Dirac (St. John's Coll., Cambridge, Eng.). Nature, 204: 771-2(Nov. 21, 1964).

Discussions concerning the validity of the unitary operator which connects the Heisenberg and Schroedinger pictures in quantum electrodynamics are presented. (J.R.D.)

8269 COUPLED OSCILLATORS AND NEGATIVE PROBABILITIES. L. M. Scarfone (Univ. of Vermont, Burlington). Nuovo Cimento (10), 34: 1184-94(Dec. 1, 1964).

Two Lee-type oscillators are coupled for the purpose of studying, in as elementary a manner as possible, the negative-probability problems occurring in a theory with more than one renormalization constant which may be less than zero. These constants are expressed in terms of variable renormalization parameters, and the negative-probability implications for the two lowest nontrivial subspaces are analyzed. (auth)

8270 ON THE GREEN'S FUNCTIONS ASSOCIATED TO THE WIGNER'S LITTLE GROUP. A. Giovannini and M. Verde (Università, Turin). Nuovo Cimento (10), 34: 1306-13(Dec. 1, 1964).

The irreducible unitary representations of the Wigner's little groups, excluding the homogeneous Lorentz group in four dimensions, were investigated using the Green's-function method. (auth)

8271 ON A FOUR-COMPONENT SPINORIAL EQUATION FOR NEUTRINO IN THE PRESENCE OF GRAVITATION IN THE CASE OF A NONLOCAL SPIN CONNECTION. T. Toró (Univ. of Timisoara, Romania). Nuovo Cimento (10), 34: 1391-3(Dec. 1, 1964).

The neutrinic field equation is established for interaction with the gravitational field. The covariant derivative of the spinor in the Fock-Ivanenko-Weyl sense is used to write the neutrino equation in the presence of a gravitational field. The fundamental link between space and spin is expressed by the generalized Dirac matrices as functions of 4-dimensional coordinates. Using the spinor covariant derivative, the 4-component spinorial equation of the neutrino is set up, for the cases of a nonlocal spin connection and a partially-local one. (M.J.T.)

8272 QUANTUM TRANSPORT EQUATIONS. I. ELECTRON-IMPURITY SYSTEM. A. Ron (Univ. of California, San Diego, La Jolla). Nuovo Cimento (10), 34: 1494-1510 (Dec. 16, 1964).

A quantum transport equation for the response of a model electron-impurity system to an electric field is derived for arbitrary frequency. The study is based on the introduction of equations of motion for the diagonal and off-diagonal elements of the density matrix of the electrons, interacting with randomly distributed fixed impurity centers. These equations are treated as changing on the same time scale and, further, both the diagonal and off-diagonal elements of the density matrix are driven by the external field. The transport equation may be reduced to a Boltzmann-type equation for slowly varying fields. If the external field changes rapidly, the results are different and, moreover, an explicit statement of the conductivity is possible. The treatment is restricted to weak scattering potentials. (auth)

8273 QUANTUM TRANSPORT EQUATIONS. II. ELECTRON-PHONON SYSTEM. A. Ron (Univ. of California, San Diego, La Jolla). Nuovo Cimento (10) 34: 1511-28(Dec. 16, 1964).

The response of an electron-phonon system to an electric field with arbitrary frequency is studied employing a quantum-mechanical transport equation. Starting from the Fröhlich hamiltonian in its second quantized form, the equations of motion of the electron and phonon distribution functions and correlation functions in an electric field are derived.

Taking into account the distinct role of the weak electron-phonon interaction and the smallness of the external field, an approximate set of equations is introduced. In the general case of arbitrary frequency of the applied field, this set is reduced to a generalized transport equation for the electron distribution function. The transport equation is reduced to a Boltzmann-like equation for slowly varying field, with proper account for the phonon drag and umklapp processes. If the field changes rapidly the usual Boltzmannlike theory is not valid. Further, in the latter case an explicit statement of the conductivity is possible. (auth)

8274 LINEAR EUCLIDIAN THEORY OF GRAVITATIONAL FIELD AND EXPERIMENTAL TESTS. S. Mavridès (Université, Paris). Nuovo Cimento (10), 34: 1529-43(Dec. 16, 1964). (In French)

The consequences of the energy-momentum conservation law (using the eulerian metrical tensor) in a phenomenological linear theory of gravitation are investigated. It is shown that it is possible to give account of the three classical tests: motion of the perihelia, deflection of light, and redshift. (auth)

8275 NATURAL-TIME MEASUREMENTS IN A HARMONICALLY VIBRATING SYSTEM. J. E. Romain and D. N. Peden (General Dynamics Corp., Fort Worth, Tex.). Nuovo Cimento (10), 34: 1544-62(Dec. 16, 1964).

A method was recently proposed for studying the time measurements in a system of reference attached to a uniformly accelerated clock-observer. The essential features were a) assigning to each point of the noninertial frame of reference a motion of the particular type considered, and b) imposing a rigidity condition in the form of the requirement that the velocity of light, as measured in the noninertial frame, be time-independent. This method is now applied to a case of nonuniform acceleration, namely, the case in which the accelerated clock-observer undergoes a rectilinear harmonic motion. It turns out that the application of the procedure in the same strict form as earlier leads to an incompatibility, which can be traced to a conflict between two rigidity conditions. The excessive constraint can be eliminated either by weakening the rigidity condition b) to the looser requirement for local radar rigidity, or by weakening condition a) through specification of the motion of the actual clock-observer only. The first approach yields a solution (in differential form) which is incompatible with the usual assumption that the time t′ in the noninertial system is identical to proper time. This result proves that, of the following three assumptions, at least one must be discarded: local radar rigidity, identity of t′ with proper time, and requirement that each point of the accelerated frame R′ undergoes a harmonic motion. The second approach, which appears to be physically preferable, furnishes a solution in which the relative rate of the noninertial clock with respect to the inertial clocks is left completely undetermined. This result proves that the proper time assumption is logically independent of the postulates used in this approach and indicates that these postulates are too weak to provide a completely determined solution of the problem. An outlook on possible directions for further investigations is given. (auth)

8276 A PROPERTY OF EINSTEIN SPACE-TIME. P. Rastall (Univ. of Texas, Austin). Nuovo Cimento (10), 34: 1563-70(Dec. 16, 1964).

If σ_μ is a reference tetrad at an event P of space-time, then the bivectors $V_{\mu\nu} = \sigma_{[\mu}\bar{\sigma}_{\nu]}$ span a three-dimensional complex vector space, and any infinitesimal circuit in the neighborhood of P can be correlated with a vector dz of this space. If a tetrad is parallely propagated around the circuit, it suffers an infinitesimal Lorentz transformation, which may be described by an antiselfadjoint quaternion dq. In a general space-time, dq is the sum of a term linear and a term antilinear in dz. The necessary and sufficient condition for the space-time to be Einstein is that the antilinear term should vanish, so that dq = kdz, where k is a complex number. This result is applied to show how, in principle, one can distinguish Einstein from non-Einstein space-time by means of a simple experiment. (auth)

8277 A VARIATIONAL METHOD FOR FINDING EIGENVALUES OF THE LIPPMANN-SCHWINGER EQUATION AND THE CORRESPONDING REGGE TRAJECTORIES. J. Wright and M. Scadron (Univ. of California, Berkeley). Nuovo Cimento (10), 34: 1571-81(Dec. 16, 1964). (UCRL-11397)

A variational principle for finding approximate eigenvalues and eigenfunctions of the kernel of the Lippmann-Schwinger equation is developed. Regge trajectories are then easily found from the solution to the eigenvalue equation. The variational principle is applied to other potential-theory calculations with very good results in both accuracy and simplicity. (auth)

8278 HIGH ENERGY BEHAVIOUR OF DIAGRAMS WITH CROSSED LINES. F. Kaschluhn and W. Zoellner (Humboldt-Universität, Berlin). Nuovo Cimento (10), 34: 1618-32(Dec. 16, 1964).

The analytic behavior in the angular momentum plane is studied for the series of iterated diagrams with two crossed lines in φ^3-theory. The corresponding integral equation for the scattering amplitude which is of positive signature on the mass shell is solved in Fredholm form and it is shown that the series expansions are convergent for Re $l > -\frac{1}{2}$ in the cut s-plane. Since the kernel of the integral equation is nonseparable the scattering amplitude has an accumulation of Regge poles at $l = -1$ in accordance with the Gribov-Pomeranchuk result. In the weak coupling limit the rightmost Regge poles must tend to $l = -1$. (auth)

8279 GENERALIZATION OF THE PHASE METHOD TO MULTICHANNEL POTENTIAL SCATTERING. A. Degasperis (Istituto Superiore di Santità, Rome). Nuovo Cimento (10), 34: 1667-86(Dec. 16, 1964).

The evaluation of the S-matrix in a multichannel potential problem is reduced to the solution of a first-order nonlinear matrix differential equation. The two-channel problem is discussed in detail; first-order differential equations for the eigenphase-shifts and the mixing parameter are obtained. Approximate expressions and bounds for the phase-shifts are also given. (auth)

8280 ASYMPTOTIC NATURE OF THE PERTURBATIVE EXPANSION FOR THE SCATTERING PARAMETERS DUE TO A POTENTIAL WHICH BEHAVES IN THE ORIGIN AS $gr^{-2}\ln(R/r)$. F. Calogero and M. Cassandro (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 34: 1712-18(Dec. 16, 1964).

The perturbative expansion for the scattering parameters produced by a potential which behaves in the origin as gr^{-2} ln (R/r) is finite term by term. This is in contrast with the perturbative expansion for the wave function, in which every term is divergent. However the perturbative expansion for the scattering parameters diverges, although it provides an asymptotic expression of the exact solution in the case in which this exists, i.e., for $g > 0$. The discussion concentrates on S-wave zero-energy scattering on a specific potential; the generalization to arbitrary values of l, k and to arbitrary potentials (with the same behavior in the origin) would not change the results. Speculations on the possible analogy of this situation with that of certain relativistic field theories are mentioned. (auth)

8281 ASYMPTOTIC LIMIT OF VERTEX FUNCTIONS IN PERTURBATION THEORY. M. Cassandro and M. Cini (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 34: 1719-31(Dec. 16, 1964).

The asymptotic behavior of the Feynman diagrams for the vertex function with two external lines on the mass shell is studied. The leading contributions of each order are explicitly summed in the case of spinor electrodynamics with heavy photons. The connection with the off-shell case is also discussed. (auth)

8282 RELATIVISTIC FIELD THEORIES WITH SYMMETRY-BREAKING SOLUTIONS. G. Jona-Lasinio (CERN, Geneva). Nuovo Cimento (10), 34: 1790-5(Dec. 16, 1964).

The possibility that a relativistic field theory, defined

by a lagrangian invariant under a certain transformation group, might possess unsymmetrical solutions is considered. The analogy between the partition function in statistical mechanics and the vacuum expectation value of the S-matrix in relativistic field theories is discussed. They both allow one to construct functionals that generate the time-ordered Green's functions. The conditions for the existence of solutions in a relativistic field theory possessing a certain basic invariance property are reduced to a variational problem. To this end, an appropriate functional of the vacuum expectation values of the field variables is introduced. An invariance property of this makes it possible to prove and give a precise meaning to the degeneracy of the anomalous solutions. A formal derivation of the Goldstone theorem is presented. A stability property common to both the normal and the symmetry-breaking solutions is discussed. (C.E.S.)

8283 SOME REMARKS ON THE EXPONENTIAL DECREASING OF FIXED-ANGLE SCATTERING AMPLITUDE. T. Kanki (Purdue Univ., Lafayette, Ind.). Nuovo Cimento (10), 34: 1805-8(Dec. 16, 1964).

Properties of the scattering amplitude when it decreases along the positive real axis as $|T(s,\cos\theta)| \sim \exp[-C_2 s^{\alpha}(\ln\varphi(s))^{\gamma}]$ for $s \to +\infty$, where $\cos\theta$ is fixed at a certain value and $C_2 > 0$, $\alpha > 0$, and $\varphi(s)$ is bounded by a finite polynomial in s, are discussed. It is shown that the exponential decrease of the amplitude is a direct consequence of the divergence of the phase of the scattering amplitude in the unphysical region ($s < 0$) and that T(s) will increase exponentially as $s \to -\infty$, unless $\alpha \leq \frac{1}{2}$. (C.E.S.)

8284 ON THE GENERALIZATION OF THE OKUBO IDENTITY FOR SU_n. Gliozzi (Università, Turin). Nuovo Cimento (10), 34: 1813-15(Dec. 16, 1964).

It was previously shown that the Gell-Mann-Okubo mass formula is a direct consequence of the Okubo identity, $A^{\alpha}_{\psi} A^{\beta}_{\alpha} A^{\mu}_{\beta} + aA^{\alpha}_{\psi} A^{\mu}_{\alpha} + bA^{\mu}_{\psi} = 0$, where A^{μ}_{ψ} are the representations of the infinitesimal operators of SU_3 and a,b are functions of the representation. An attempt is made to show how to explicitly construct the analogous identities for any SU_n group. (C.E.S.)

8285 A THEOREM ON THE ZEROS OF CAUSAL TRANSFORMS. A. S. Marathay and P. Roman (Boston Univ.). Nuovo Cimento (10), 34: 1821-2(Dec. 16, 1964).

A theorem that relates the zeros of causal transforms belonging to folded spectra is reported. The spectrum $g(\nu)$ is a causal function, $g(\nu) \equiv 0$ for $\nu < 0$ and $g(\nu)$ is real and non-negative. Its Fourier transform is $\gamma(\tau) = \int_0^{\infty} g(\nu) \exp[i2\pi\nu\tau]d\nu$. The folded spectrum is defined as $g'(\nu) = g(2\nu_0 - \nu)$, where ν_0 is an arbitrary positive frequency. The Fourier transform of $g'(\nu)$ is denoted by $\gamma'(t)$. It is shown that if γ has a zero at $\tau = \tau_n$, then γ' will have a zero at the origo-reflected position $\tau' = -\tau_n$. The theorem has the corollary: If $g(\nu)$ is a real, non-negative causal function with a cutoff and if, moreover, it has a symmetric shape about some frequency ν_0, then the zeros of $\gamma(\tau)$ are symmetric in the complete τ-plane with respect to both the imaginary and real axes. (C.E.S.)

8286 A CONVOLUTION INTEGRAL FOR THE RESOLVENT OF THE SUM OF TWO COMMUTING OPERATORS. L. Bianchi and L. Favella (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 34: 1825-8(Dec. 16, 1964).

In dealing with many problems in scattering theory one is often faced with the determination of the resolvent of the sum of two independent operators, their own resolvents being known. Two bounded commuting operators A_1 and A_2 and $R(\lambda;A_1)$, $R(\lambda;A_2)$ their resolvents, defined by $R(\lambda;Ai) = (\lambda - Ai)^{-1}$, are considered. The theorem is proved that $R(\lambda;A_1 + A_2) = (\lambda - A_1 - A_2)^{-1} = 1/2i\pi \int_C R(\lambda';A_1)R(\lambda - \lambda';A_2)\,d\lambda'$ where the path of integration C in the complex λ'-plane encircles in a counterclockwise direction the whole spectrum (discrete + continuum) of $R(\lambda';A_1)$, or that of $R(\lambda - \lambda';A_2)$ in a clockwise direction. (C.E.S.)

8287 ON THE FOKKER-PLANCK COEFFICIENTS FOR AN INVERSE SQUARE LAW FORCE. N. E. Frankel (Univ. of Melbourne). Phys. Letters, 13: 315-16(Dec. 15, 1964).

The friction and dispersion coefficients of the Fokker-Planck equation for two-body Coulomb scattering were derived using the exact form of Λ and compared with coefficients obtained by the approximate treatment. (C.E.S.)

8288 ANALYSIS OF SCHWARZSCHILD'S SOLUTION. R. Horak (Palacky Univ., Olomouc, Czechoslovakia). Phys. Letters, 13: 318-19(Dec. 15, 1964).

The spherical symmetrical solutions of the field equations are analyzed, and the mathematical results are interpreted in a physical way. The position of singularities and the distribution of the radial velocity and of the gravitational potential in space-time are studied. (C.E.S.)

8289 SPECTRAL FUNCTIONS AND LAGRANGIAN THEORIES. W. S. Hellman and P. Roman (Boston Univ.). Phys. Letters, 13: 336-7(Dec. 15, 1964).

Previous investigations concerning the restrictions placed on Lagrangian field theories arising from the requirement of consistency with the spectral representations of the two-point functions for these theories are discussed. The restrictions take the form of conditions on the wave function renormalization constants and on the mass shifts occurring in the models considered. In these investigations the positive definiteness of the spectral weight function was crucial for the results. It is suggested that the requirement of positive definiteness might be too strong. A model of nucleons and mesons(π) with pseudoscalar coupling, with the bare meson(π) mass set equal to zero, is considered. (C.E.S.)

8290 ON THE CONCEPT OF HIGHER SYMMETRY GROUPS. W. Ruehl (CERN, Geneva). Phys. Letters, 13: 349-50(Dec. 15, 1964).

The problem of constructing a Lie group G that contains as subgroups the Poincaré group P and an internal symmetry group S is investigated. The concept of a certain invariant subgroup T of space-time translations is introduced. (C.E.S.)

8291 ON THE ALGEBRA OF SU_6. A. Salam (International Centre for Theoretical Physics, Trieste, Italy). Phys. Letters, 13: 354-5(Dec. 15, 1964).

The relativistic basis of the SU(6) algebra is considered. (C.E.S.)

8292 COVARIANT POSITION OPERATORS, SPIN, AND LOCALITY. Gordon N. Fleming (Univ. of Washington, Seattle). Phys. Rev., 137: B188-97(Jan. 11, 1965). (TID-21042)

A manifestly covariant formalism is developed suitable for a discussion of position operators for relativistic systems. It is shown that the rest-frame and the frame-dependent center of mass, and the local Newton-Wigner operator all transform like the spatial part of a four-vector when appropriately interpreted. The formalism allows an equivalent treatment of the space and time components of a position four-vector operator, and manifestly covariant canonical commutation rules are obtained for the three operators mentioned above. Finally it is suggested that the Newton-Wigner operator be interpreted as a center of spin. (auth)

8293 DENSITY-OPERATOR THEORY OF HARMONIC OSCILLATOR RELAXATION. W. H. Louisell and L. R. Walker (Bell Telephone Labs., Murry Hill, N. J.). Phys. Rev., 137: B204-11(Jan. 11, 1965).

The reduced density operator for a driven electromagnetic field mode relaxing to a bath of oscillators is formally found in closed form. In the limit of weak coupling, the density operator which maximizes the entropy subject to the constraints of a given average energy and average electric and magnetic field remains invariant under interaction with the bath. The quantum characteristic function is found in the weak-coupling case and agrees with previous results. The method may be generalized to many modes relaxing to a bath of oscillators. (auth)

8294 SELF-FIELD FLUCTUATIONS AND THE MEASURABILITY OF ELECTROMAGNETIC POTENTIALS IN

QUANTUM MECHANICS. R. Rockmore (Rutgers Univ., New Brunswick, N. J. and Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B219-20(Jan. 11, 1965). (BNL-8167)

Some earlier considerations of Mitler on the significance of electromagnetic potentials in quantum theory which attempt to take properly into account the fluctuations of the vacuum are re-examined in terms of the conventional formalism of quantum field theory. It is shown that, contrary to the conclusions reached by Mitler, the effects of self-field fluctuations are indeed small, in substantial agreement with remarks of Aharonov and Bohm on this subject. (auth)

8295 CONVERSE RED-SHIFT ARGUMENT. Elihu Lubkin (Brown Univ., Providence). Phys. Rev., 137: B221-?(Jan. 11, 1965).

It is argued that: if there is a sufficiently uniform red shift operating on light signals traveling in either direction between A and B, the round-trip distance, defined as the time it takes for a light signal to go from A to B and back, increases with the time measured by A. (auth)

8296 GENERALIZED SELF-CONSISTENT-FIELD THEORY: GOR'KOV FACTORIZATION. Morrel H. Cohen (Univ. of Chicago). Phys. Rev., 137: A497-507(Jan. 18, 1965).

Gor'kov factorization, $\langle\psi^\dagger(1)\psi^\dagger(2)\psi(3)\psi(4)\rangle \to \langle\psi^\dagger(1)\psi^\dagger(2)\rangle\langle\psi(3)\psi(4)\rangle$, is made the basis of a generalized self-consistent-field (SCF) theory precisely analogous to that previously developed for Hartree factorization, $\langle\psi^\dagger(1)\psi^\dagger(2)\psi(3)\psi(4)\rangle \to \langle\psi^\dagger(1)\psi(4)\rangle\langle\psi^\dagger(2)\psi(3)\rangle$. The generalized SCF method is reviewed in the context of Gor'kov factorization. The corresponding simple SCF theory is developed to illustrate the method and is shown to give a simple hamiltonian version of the Bardeen-Cooper-Schrieffer theory of superconductivity and, more generally, of coherent pairing. The notion of an external pairing field is introduced and the corresponding response functions developed via a formalism like that of Kubo. General fluctuation-dissipation theorems are proved for the response functions. An equation of state is then obtained by a formulation analogous to the dielectric formulation. The insertion of the simple SCF approximation to the response function into the equation of state yields a generalization of the usual low-density (or short-range) evaluation of the grand potential to arbitrary temperatures. Screening the bare interaction with this approximate response function converts the former into the t matrix of the independent-pair approximation. The entire analysis gives an underlying unity to the currently disparate treatments of superconductivity, of long-range correlations, and of short-range correlations. (auth)

8297 FOURTH TEST OF GENERAL RELATIVITY. Irwin I. Shapiro (Massachusetts Inst. of Tech., Lexington.). Phys. Rev. Letters, 13: 789-91(Dec. 28, 1964).

A test of Einstein's theory of general relativity is discussed. The test involves measuring the time delays between transmission of radar pulses toward either of the inner planets (Venus or Mercury) and detection of the echoes. Since, according to the general theory, the speed of a light wave depends on the strength of the gravitational potential along its path, these time delays should therefore be increased by almost 2×10^{-4} sec when the radar pulses pass near the sun. (C.E.S.)

8298 THREE-FIELD MODEL AS A PROBE OF HIGHER GROUP SYMMETRIES. S. Okubo and R. E. Marshak (Univ. of Rochester, N. Y.). Phys. Rev. Letters, 13: 818-22(Dec. 28, 1964).

A useful probe of mixed group symmetries is proposed. The probe is a model based on a triplet of basic fields interacting via a four-fermion interaction. The basic field is a massless Dirac four-component field. It is shown how the three-field model (with γ_4 diagonalization) can produce a mixing of the proper orthochronous Lorentz group with the internal symmetry groups at the expense of enlarging the underlying group to an infinite number of dimensions. (C.E.S.)

8299 NOTE ON THE CALCULATION OF REGGE TRAJECTORIES IN POTENTIAL THEORY BY THE SECOND-ORDER W.K.B. APPROXIMATION. J. I. Boukema (Univ. of St. Andrews, Scotland, U.K.). Physica, 30: 1909-12(Oct. 1964).

It is shown how the 2nd order W.K.B. approximation can be adapted to find Regge trajectories in potential theory. As an illustration, nonrelativistic trajectories are calculated for a generalised Yukawa type potential; comparison of the results with those obtained from perturbation theory indicates that the method is of high accuracy despite its simplicity. (auth)

8300 QUASI-PARTICLE FORMULATION OF QUANTUM STATISTICS. R. Balian and C. De Dominicis (Centre d'Etudes Nucléaires, Saclay, France). Physica, 30: 1927-32(Oct. 1964).

Results are presented which express the thermodynamical functions of a normal inhomogeneous system as stationary functionals of a matrix ϕ_{mn}. The eigenvalues of ϕ are quasi-particle occupation numbers. The relation with Landau theory of Fermi liquids is discussed. The rules necessary to construct the relevant functionals of ϕ, including the one-body Green's function, in powers of the two-body interaction, are explicit. (auth)

8301 MICROSCOPIC APPROACH TO THE LANDAU THEORY OF THE BOSE LIQUID. R. Balian and C. De Dominicis (Centre d'Etudes Nucléaires, Saclay, France). Physica, 30: 1933-7(Oct. 1964).

An extension of a previous quasi-particle formulation of statistical mechanics is described, which applies to a Bose system below the transition temperature. Its relation to the Landau theory of the Bose liquid, for which it provides a microscopic foundation, is discussed. (auth)

8302 QUANTUM FIELD THEORY AND THE DYNAMICAL ROLE OF SPIN. Francois Lurcat (Universite de Paris, Orsay, France). Physics, 1: 95-106(Sept.-Oct. 1964).

The current assumption in elementary particle physics, that the spin is an unessential complication and plays no dynamical role, is criticized. This assumption has no experimental ground; it is merely a consequence of the wave equations used, especially in field theory. To eliminate it, wave functions and fields must be defined as functions, not on Minkovski space, but on the Poincaré manifold (i.e., the manifold of the Poincaré group). The result is a Poincaré field theory, for which the general features of field theory (relativistic invariance, locality, definition of free fields) are formulated. The spectral condition is only sketched. A physically important result is a generalized Källèn-Lehmann representation of the two-point function, where the spectral function depends on the mass and also on the spin. As a consequence, the peaks in this spectral function represent particles which may have different spin values, and (when they are unstable) a spin spectrum as well as a mass spectrum. The notion of Regge trajectory appears as a particular case. (auth)

8303 ALTERNATIVE DERIVATION OF THE MOMENT RELATIONS INVOLVING SCATTERING PHASE SHIFTS. M. J. Roberts (London Univ.). Proc. Phys. Soc. (London), 84: 825-6(Nov. 1964).

The regularized moments of the scattering phase shift $\delta_l(k)$ which have been derived by Buslaev and Faddeev, Percival, and by Percival and Roberts are obtained from the previous work of Verde on the asymptotic expansion of $\delta_l(k)$ for large k. The first and second moments are given explicitly for an arbitrary l. (auth)

8304 UNITARY TRANSFORMATIONS IN SCATTERING THEORY. A. M. Arthurs (Univ. of York, Eng.) and A. R. Holt. Proc. Phys. Soc. (London), 84: 833-4(Nov. 1964).

The hamiltonian of a scattering system is diagonalized to first order in the interaction by means of a unitary transformation. This procedure is used to study heavy particle collisions at moderate energies. (auth)

8305 THE BOGOLIUBOV TRANSFORMATION IN THE FIELD THEORY. THE MASS EQUATION. Takao Okabayashi, Kôsai Tanabe, and Masao Yamada (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 619-46(Oct. 1964).

It is confirmed that the method of the Bogoliubov transformation is applicable also in the field theory. The original representation suited for a massless spinor field, $\psi^{(0)}$, can be transformed into another representation, in which the spinor field has a non-zero mass for the Fermi interactions of any type by the transformation. But the interaction responsible for the finite mass is the scalar part of the interaction itself or of the equivalent expression obtained by the Fierz transformation. As to the Yukawa interaction, the Bogoliubov transformation must be accompanied by a linear transformation for the Bose field, and the combined transformation is meaningful only for the scalar coupling of a scalar meson with mass. The situation about the ϕ^4 interaction of spinless fields ϕ is completely the same as in the case of the Fermi interaction, but the method is not applicable to the ϕ^3 interaction of a scalar field. Thus it is suggested that the quantities $\ll:\bar{\psi}^{(0)}\psi^{(0)}:\gg$ for the Fermi interaction, $\ll\phi^{(0)}\gg$ for the Yukawa interaction, and $\ll:\phi^{(0)2}:\gg$ for the ϕ^4 interactions correspond to the parameter of the long range order in the theory of superconductivity, respectively, where the notation $\ll\ \gg$ means the expectation value in the transformed vacuum. It is also shown that Lehmann's method of the spectrum representation can be generalized to treat the canonical transformation, and that it gives a covariant and convenient method to derive the mass equation. It is discussed what kinds of image or assumption must be introduced in order that the representation obtained by the Bogoliubov transformation can be used to the unified theories of elementary particles. Counter-examples to the too conventional method used in the theories of spontaneous breakdown of symmetries are also exhibited. (auth)

8306 REGGE BEHAVIOUR FOR THE SCATTERING UNDER A POTENTIAL WITH A SINGULARITY AT ORIGIN HIGHER THAN z^{-2}. Yuan-ben Dai. Wu Li Hsueh Pao, 20: 863-72(Sept. 1964). (In Chinese)

Assuming that the potential $V(z) \to z^{-n}$ $(n > 2)$ as $z \to 0$, V is regular in Re $z > 0$, and $V(z)z^2 \to 0$ as $z \to \infty$ in $|\arg z| < (\pi/2)$, the following assertions are proved: the scattering matrix element S is meromorphic in the whole λ plane [$\lambda = l + (1/2)$, l—angular momentum] and $S - 1 \to O(\log|\lambda|/|\lambda|)$ as $\lambda \to \infty$ in $|\arg\lambda| < (\pi/2)$. (auth)

8307 THE ANALYTICITY IN THE COMPLEX ANGULAR MOMENTUM VARIABLE OF THE S MATRIX ELEMENT FOR A CLASS OF NONLOCAL POTENTIALS. Yuan-ben Dai. Wu Li Hsueh Pao, 20: 947-53(Oct. 1964). (In Chinese)

For a class of nonlocal potentials, the S matrix element is proved to be analytic in the right half λ plane except at the poles. (auth)

8308 RELATION BETWEEN OPERATORS IN THE HEISENBERG AND INTERACTION REPRESENTATIONS IN LOCAL QUANTUM THEORY OF FIELDS. A. D. Sukhanov (Karpov Inst. of Physics and Chemistry, USSR). Zh. Eksperim. i Teor. Fiz., 47: 1303-14(Oct. 1964). (In Russian)

The problem of establishing the correct relationship between the renormalization operators in the Heisenberg representation and the free operator is considered by perturbation theory. For this purpose two types of T-products (Wick and Dyson) are introduced, the contractions of which differ by quasi-local terms in the case of field derivatives. Therefore, althouth the S-matrix may be expressed in terms of any of the T-products (with simultaneous substitution of $H_I^n(x,\sigma)$ for $L_I^n(x)$) in any local field theory, two possibilities exist for the determination of the Heisenberg operators. The approach chosen in the present paper corresponds to a nonunitary relation between the operators and ensures independence from σ of the renormalized Heisenberg operator. A correct method for determining the $S(\sigma,-\infty)$ matrix and interaction Hamiltonian in the interaction representation is proposed. (auth)

8309 ON AN ALLOWED MODEL IN QUANTUM ELECTRODYNAMICS. S. S. Sannikov and E. I. Dubovoi. Zh. Eksperim. i Teor. Fiz., 47: 1345-53(Oct. 1964). (In Russian)

The Lee annihilation model in quantum electrodynamics is considered in which transitions of the type $\gamma \rightleftarrows e^- + e^+$ are the only permissible ones. The model is set up in such a way that it leads to a causal description of the processes. On basis of this model the photon state is constructed and scattering of electrons by positrons is considered (some limiting expressions for the cross section of the process are found in this case). The expressions for the amplitude and cross sections of the processes thus derived can apparently be regarded as majorants of the respective quantities in the exact theory in the limiting case of high energies. (auth)

8310 THE STATES OF ZERO MASS FIELDS WITH NONSCALAR PHASES. R. V. Smirnov. Zh. Eksperim. i Teor. Fiz., 47: 1386-8(Oct. 1964). (In Russian)

Three component vector and four component spinor phases are introduced. It is showed that for zero mass and Klein–Gordon fields it is possible to construct solutions with these phases, and these solutions, analogous to scalar phase solutions, are independent of the Lorentz frame of reference. (auth)

8311 CONNECTIONS BETWEEN FIELD THEORY AND AXIOMATIC S-MATRIX THEORY. M. Dresden (Univ. of Iowa, Iowa City). p.185-204 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

A critical discussion of developments in field theory is given. The s-matrix formalism of Stapp is compared with the Lagrangian or abstract field theory description. An example of Zachariasen, which shows the relations between the Lagrangian and the dispersion theoretical forms, is considered. Comments on the assumptions and character of the various forms of field theory are made, and a brief discussion of the Zachariasen model is given. The postulates of Stapp, together with a comparison with other postulates, are presented. (L.B.S.)

8312 TOPICS IN QUANTUM ELECTRODYNAMICS. Donald R. Yennie (Univ. of Minnesota, Minneapolis). p.165-258 of "Lectures on Strong and Electromagnetic Interactions." Waltham, Mass., Brandeis University, 1963.

Two problems in quantum electrodynamics—operator techniques in the Lamb shift calculation and the infrared divergence problem—are approached without a sophisticated knowledge of quantum field theory, and both are considerably refined without the use of advanced mathematical techniques. Excellent agreement with experiment was found for Lamb shift calculations, which gives good confirmation of quantum electrodynamics in atomic physics. The emission of one real photon during a scattering process is treated both classically and quantum mechanically; the infrared divergence in elastic scattering to all orders in the soft photons and the radiative corrections are discussed. Remarks of the physical significance of the infrared divergence are given. (L.B.S.)

8313 THE EXISTENCE AND SIGNIFICANCE OF PARASTATISTICS. Max Dresden (Iowa State Univ., Iowa City). p.377-469 of "Lectures on Astrophysics and Weak Interactions. Vol. 2." Waltham, Mass., Brandeis University, 1963.

A detailed and rigorous investigation of the possibility of intermediate or parastatistics was made. The permutation group, Young diagrams, and the formulation of the permutation invariance requirement are discussed. Proofs demonstrating the nonexistence of intermediate statistics are presented with emphasis on precise mathematical formulation of physical ideas and the physical sense of mathematical postulates. A self-contained treatment of the

formal construction of systems obeying parastatistics is given, and the physical aspects of parastatistics leading to questions in the assignment of statistics and in the interpretation of quantum theory is emphasized. Attempts to connect the strangeness properties of fundamental particles with parastatistics are considered, and a general result of all possible statistics and a summary of the current status of parastatistics are given. (L.B.S.)

8314 ELECTRON INTERACTIONS IN CRYOGENIC HELIUM PLASMAS. Paul David Goldan. Thesis, Chicago, Univ. of Illinois, 1964. 136p.

Electron interactions in decaying helium afterglow plasmas, maintained near 5°K, were determined from electronic microwave conductivity measurements. Experiments were performed for neutral densities in the range 2×10^{17} to 1.2×10^{19} atoms/cc. Concurrently, electron temperatures were inferred from microwave noise radiation from the afterglow plasma and microwave interaction measurements. At times during plasma decay when the indicated electron temperature was 300°K, microwave conductivity measurements yielded a value of the electron-helium collision cross section for momentum transfer in good agreement with the determinations of other workers. When measurements indicated the electron gas to be in thermal equilibrium with the parent gas, an effective collision cross section of 1.9×10^{-15} cm^2 was determined at the low end of the above density range computed on the basis of binary collision theory. A significant saturation effect was observed toward the high end of the experimental density range. The use of microwave interaction techniques permitted the determination of the electron energy relaxation rates over the same density range. Interpretation of these results, in terms of binary collision theory, gave a value for the electron-helium collision frequency in disagreement with that determined from the microwave conductivity by as much as a factor of 15 at the higher densities and approaching zero as the neutral density was decreased. Electron temperature decay rates some two orders of magnitude slower than would be expected solely on the basis of elastic recoil with other plasma constituents were observed. From the pressure dependence of the electron thermal relaxation time, a cross section of 6×10^{-20} cm^2 at 4.2°K was deduced for the collisional de-excitation of these metastable atoms by atoms in the ground state. Interpretation of afterglow light quenching experiments indicates that electron recombination loss in such low temperature helium plasmas may be controlled by the rate of production of helium molecular ions. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8315 A SEMICLASSICAL TREATMENT OF A MULTIPLE QUANTUM TRANSITION. Michael Joseph Duggan. Thesis, Stanford, Calif., Stanford Univ., 1964. 89p.

The type of multiple quantum transition discussed here occurs in a material system with two levels connected by dipole matrix elements in the presence of a radiation field. The process consists of the emission or absorption of an odd number of equi-energetic quanta, and occurs without benefit of intermediate states of the material system. A perturbation theory treatment of a single particle interacting with a single mode of a quantized radiation field is given. This treatment demonstrates the existence of the transitions, exhibiting the effect as due to energy gaps in the spectrum of energy levels in the system of particle and radiation field. The transitions occur when the field quanta have approximately $1/n$ (n odd) of the energy separating the two levels of the material system in the absence of the radiation, and the transition times are shown to be inversely proportional to the energy gaps of the complete system. A semiclassical approach is used for the treatment of the more realistic situation of many particles interacting with a radiation field of more than one mode, taking account of the effect of the material system upon the field. A review is given of the concepts of this approach and its relation to quantum electrodynamics. The method is then used to study the behavior of a system of two-level atoms interacting with a radiation field of two modes (ω and 3ω) when the higher frequency mode is near the two-level resonance. Interactions are taken into account by the addition of empirical relaxation terms to the equations of motion. The results are applied in a numerical example of frequency conversion upward by a factor of three, using magnetic dipoles in a steady field for the two-level atoms. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8316 CONTRIBUTION TO THE COHERENCE THEORY OF THE ELECTROMAGNETIC FIELD. Yutaka Kano. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 141p.

The basic equations derived by Roman and Wolf (1960) for the correlation tensors of stationary electromagnetic fields are rederived using a relativistic treatment. The relation between the modulus of the complex degree of coherence and its phase (dispersion relation) is discussed. The coherence properties of black-body radiation are then studied. Particular attention is paid to time coherence of this radiation and the analytic properties of the corresponding time coherence correlation function $\gamma(\tau)$ are investigated. It is shown that the analytic continuation of $\gamma(\tau)$ has no zeros at all in half of the complex τ-plane. This result has an important bearing on a current theory relating to the possibility of determining energy distribution in spectra of light beams from measurements of the absolute value of the degree of coherence of the light. The basic equations satisfied by the correlation tensors for stationary electromagnetic fields are generalized to non-stationary cases. In the appendices, mathematical foundations required for the analysis of the above problems are discussed. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8317 BAND STRUCTURE AND FERMI SURFACE OF BERYLLIUM. Terry Lee Loucks. Thesis, University Park, Penna; Pennsylvania State Univ., 1963. 89p.

The object of this investigation was to determine the Fermi energy, density of states, and Fermi surface of beryllium using the orthogonalized plane wave (OPW) method. In order to make the crystal potential self-consistent, all of the wave functions (conduction and core electrons) used in constructing it were taken to be solutions in the potential itself. This was achieved by a series of four iterations in which at each stage single OPW wave functions were determined using the best available form of the potential. Similarly the core wave functions were determined numerically as the ground state solutions of Schrödinger's equation using the crystal potential from the last stage of the iteration. The potential was considered to be self-consistent when the core state eigenvalue remained constant after one complete stage of the iteration. Using this self-consistent potential the energy eigenvalues were determined along the zone edges, on the zone faces and at the equivalent of 5184 general points in the first Brillouin zone. At each point a 23×23 secular determinant was solved for the lowest lying eigenvalues. The resulting Fermi energy, density of states, and Fermi surface were found to be in close agreement with all available experimental results. The Fermi surface consists of (i) a hole region in the first double zone which resembles a coronet and (ii) two identical pockets of electrons in the second double zone which are similar in appearance to a cigar of triangular cross section. The de Haas-van Alphen frequencies predicted from this theoretical surface are in close agreement with those observed experimentally. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8318 QUANTUM TRANSPORT THEORY OF FREE ELECTRONS IN A STRONG MAGNETIC FIELD. Philip B. Horton. Thesis, Baton Rouge, Louisiana State Univ., 1964. 78p.

The conduction of electricity and heat transverse to a strong magnetic field is considered in terms of a free electron model. On the basis of the isotropy of the model and the Onsager relations, with an a posteriori determination of parity, six kinetic coefficients are established as representative of all such phenomena. These six coefficients are derived by a quantum mechanical formulation using the density matrix and Landau wave functions. No upper limit is imposed on the size of the magnetic field. The equation of motion for the density matrix is solved by the Laplace transform, and by a theorem due to Kohn and

Luttinger the many-body aspects are handled rigorously. Only low temperatures are considered, and simple scattering by sparsely and randomly located neutral point impurities is assumed. The derived coefficients have components both monotonic and oscillatory as functions of reciprocal magnetic field. These components are compared with previous theories and the oscillatory components are compared with experiments on bismuth and zinc. The derived monotonic components agree with those of Wilson with two exceptions. The predicted oscillations, which are largest in the electric-thermal and thermal-electric coefficients, have the characteristic de Haas-van Alphen period and proper temperature dependence, but fail by several orders of magnitude to exhibit the amplitudes of the experimental data. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

Geophysics

Refer also to abstract 8060.

8319 ANGULAR DISTRIBUTIONS AND ENERGY SPECTRA OF ELECTRONS ASSOCIATED WITH AURORAL EVENTS. I. B. McDiarmid and E. E. Budzinski (National Research Council, Ottawa). Can. J. Phys., 42: 2048-62 (Nov. 1964). (NRC-8133)

A number of rockets containing various charged-particle detectors were fired during 1963 and 1964. Most of the firings took place at times of auroral events and the rocket instrumentation was designed to study the particles associated with these events. Pitch-angle distributions were observed for electrons with energies greater than 40 kev, which show varying degrees of isotropy in the pitch-angle range 0 to 90°. In no case was a distribution observed in which the intensity increased towards small angles. In some cases electron-intensity changes appear to be correlated with changes in spectrum and angular distribution, while in other cases changes in these quantities do not appear to be related. The particle intensity measurements are used along with radio frequency probe measurements of electron density to infer values for the nighttime recombination coefficient in the D region of the ionosphere. (auth)

8320 VARIATION IN HEIGHTS OF THE LOWER BORDERS OF AURORAL BANDS. J. H. Brandy (Defence Research Northern Lab., Fort Churchill, Manitoba, Can.). Can. J. Phys., 42: 2142-5(Nov. 1964).

The variation in height of 20 well-defined auroras was measured over projected distances from 70 to 401 km. Differences in height as large as 55 km were found between two points on the lower borders of a band. Half the auroras measured showed relatively small variations, the other half considerable. These facts may need to be taken into account in the use of single-station photographs of bands for determining auroral properties such as heights and widths. (auth),

8321 CORRELATION BETWEEN INTENSITIES OF AURORAL ABSORPTION AND PRECIPITATED ELECTRONS. Doris H. Jelly (Defence Research Telecommunications Establishment, Ottawa), I. B. McDiarmid, and J. R. Burrows. Can. J. Phys., 42: 2411-18(Dec. 1964). (NRC-8184)

Particle detectors on the Alouette I satellite and on rockets were used to study the correlation between the intensity of electrons with energies greater than 40 kev and the intensity of auroral radio wave absorption. The average relation between the intensity of precipitated electrons and the amount of absorption is in approximate agreement with that expected from theory. For the same electron flux a day-to-night absorption ratio of about a factor of two is suggested by the measurements. (auth)

8322 MAGNETIC CONJUGACY FROM L = 6 TO L = 1.4. 1. AURORAL ZONE: CONJUGATE AREA, SEASONAL VARIATIONS, AND MAGNETIC COHERENCE. Eugene M. Wescott and Keith B. Mather (Univ. of Alaska, College). J. Geophys. Res., 70: 29-42(Jan. 1, 1965).

IGY magnetograms from eleven stations in Alaska and Siberia were compared with Macquarie Island records for correlation. The conjugate area defined by contours of equal correlation coefficients varies in size, shape, and location with time, but is generally elongated along a line of constant L value. Some definite departures from conjugacy were found and are discussed. No pronounced daily or seasonal change was found in form correlation between Macquarie Island and Kotzebue. The relative size of afternoon and early evening disturbances definitely varies with season, probably as a result of seasonal changes of ionospheric conductivity. The coherence of magnetic disturbances was investigated using Alaska net magnetograms, since this affects the size and shape of a conjugate area. Tight coherence was always noted in a group of stations spread 350 km east-west and 125 km north-south. (auth)

8323 MAGNETIC CONJUGACY FROM L = 6 TO L = 1.4. 2. MIDLATITUDE CONJUGACY. Eugene M. Wescott and Keith B. Mather (Univ. of Alaska, College). J. Geophys. Res., 70: 43-7(Jan. 1, 1965).

The conjugacy of bay-type magnetic variations at midlatitude was investigated using data from the Cold Bay, Alaska, and Oamaru, New Zealand, pair (L = 2.6). Of twenty-four intervals representing positive bay activity which were examined, the majority showed substantial agreement. Eleven intervals could be considered anomalous in all or some features. At midlatitude positive bays seem to result from the return current part of auroral zone electrojets. Intervals showing noncorrelation indicate departures of the primary electrojet from a conjugate pattern. Short period magnetic pulsations were also observed as a conjugate phenomenon. They could not be studied in detail owing to the insensitivity of the magnetometers. (auth)

8324 MAGNETIC CONJUGACY FROM L = 6 TO L = 1.4. 3. LOW LATITUDE CONJUGACY. Eugene M. Wescott and Keith B. Mather (Univ. of Alaska, College). J. Geophys. Res., 70: 49-51(Jan. 1, 1965).

Data from the L = 1.4 conjugate pair, San Juan, Puerto Rico, and Trelew, Argentina, were used to study the conjugacy of low latitude magnetic variations. The majority of low latitude variations have essentially a worldwide distribution. Positive bays, however, are more limited in areal extent, and are thus of interest to a study of conjugacy. All bays examined showed similar and simultaneous variations at the conjugate stations. (auth)

8325 CYCLOTRON INSTABILITIES AND ELECTROMAGNETIC EMISSION IN THE ULTRA LOW FREQUENCY AND VERY LOW FREQUENCY RANGES. John M. Cornwall (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res. 70: 61-9(Jan. 1, 1965).

A model for the generation of pearl-type micropulsations at 0.1 to 5 cps is presented. The model is also applicable to the generation of vlf emissions in the whistler mode. It is proposed that a beam of trapped protons at $L \geq 4$, supersonic with respect to the local Alfvén speed, emits hydromagnetic waves at a frequency corresponding to the occurrence of a cyclotron instability. These hydromagnetic waves propagate along the earth's field lines and are reflected back along the line at the ionosphere. On each pass of a wave packet through the proton beam, energy is supplied to the wave by the particles via the instability. Certain features of the observed fine structure of micropulsations are explained with the concept of bouncing hydromagnetic wave packets. A possible candidate for the necessary proton beam is the belt of 200 to 500 kev protons observed by Davis and Williamson, but there are other candidates as well, including low-energy ring currents at $L \simeq 6$. Emission at 1 to 10 kc may be produced by a similar instability if a beam of energetic electrons is present. (auth)

8326 LOWER HYBRID RESONANCE EMISSIONS. N. M. Brice and R. L. Smith (Stanford Univ., Calif.). J. Geophys. Res., 70: 71-80(Jan. 1, 1965).

Examination of vlf records of the Alouette 1 satellite revealed the presence of an unusual band of noise. This band shows several features that distinguish it from other

vlf emissions observed both in the satellite and on the ground. It is suggested that this noise is generated in the immediate vicinity of the satellite as a result of a resonance in the plasma surrounding the satellite. From a knowledge of the resonance frequency and the ambient plasma and gyrofrequencies, an inverse mean of the ionic mass can be determined. (auth)

8327 RECOMBINATION AND TRANSPORT IN THE NIGHTTIME F LAYER OF THE IONOSPHERE. Thomas P. Quinn and John S. Nisbet (Pennsylvania State Univ., University Park). J. Geophys. Res., 70: 113-30(Jan. 1, 1965).

A method by which the recombination coefficient of the nighttime F region of the ionosphere can be determined was applied to results from six sounding stations at different latitudes. Further work was done on the effect of various assumptions used in the analysis. No large latitude dependence of the recombination coefficient at 300 km was observed. A large seasonal effect was found, however. The analysis was extended to the calculation of vertical diffusion and total transport velocities, and a determination of the diffusion coefficient effective in the nighttime F region was obtained. Vertical drift velocities were determined from mean monthly profiles. (auth)

8328 AN F REGION ECLIPSE. J. V. Evans (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 70: 131-42(Jan. 1, 1965).

Observations of the electron density, electron temperature, and ion temperature were made 240 to 750 km vertically above Millstone Radar Observatory on July 19-21, 1963. The technique employed was the incoherent backscatter method. The eclipse occurred on the afternoon of July 20 and caused a large rapid decrease in the electron temperature at all heights and a subsequent recovery. The ion temperature was seen to change at all heights almost equally rapidly, though by a smaller amount. These changes in temperature caused a rapid reduction in the value for the diffusive equilibrium scale height. As a consequence, ionization moved downward and the density at h_{max} increased, though at altitudes above 425 km it decreased. The total electron content of the region under study was about 7×10^{12} electrons/cm^2 at the commencement of the event but declined to about 6×10^{12} electrons/cm^2 by the time point of last contact was reached. (auth)

8329 EVIDENCE FOR TEMPERATURE STRATIFICATION IN THE E REGION. William C. Knudsen and Gerald W. Sharp (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 70: 143-60(Jan. 1, 1965).

The ion temperature of the upper atmosphere at local noon in the region from 100 to 160 km was measured directly by means of an ion trap. The ion temperature is expected to be the same as that of the neutral particles, since analysis shows that the thermal relaxation time of ions to neutrals is shorter than that of ions to plasma in the above height range. Above 120 km the experimental temperature profile contains what appears to be a wave-like temperature variation superimposed on an otherwise reasonable thermosphere profile. The peak-to-trough amplitude of the temperature variation is 200°K, and the average wavelength is approximately 12 km. The thermosphere temperature profile parallels predicted profiles but may be systematically high. At and below 115 km the shape of the profile deviates from predictions. The temperature is high and increases downward; this increase may be caused by aerodynamic heating of the ions before they enter the trap. The amplitude of the wave-like temperature variation is consistent with that expected from a gravity wave producing a horizontal wind velocity of 150 m/sec. However, the vertical wavelength is smaller than that believed possible for gravity waves in the altitude interval of interest. On the other hand, measured total extreme ultraviolet energy is insufficient to maintain a quasi-steady-state temperature profile of the shape observed. (auth)

8330 ROCKET MEASUREMENT OF MIDLATITUDE AIRGLOW AND PARTICLE PRECIPITATION. B. J. O'Brien, F. R. Allum, and H. C. Goldwire (Rice Univ., Houston, Tex.). J. Geophys. Res., 70: 161-75(Jan. 1, 1965).

Midlatitude night airglow and particle fluxes were measured simultaneously with a Nike-Apache rocket fired from Wallops Island, Virginia, near midnight and new moon in July 1964. The rocket carried two photometers, three Geiger counters, and two scintillators, and two magnetometers as aspect sensors. The experiment conclusively demonstrated with three independent techniques that midlatitude 5577 Å night airglow is not excited by charged particle bombardment as it is in auroras. First, the intensity of 3914 Å above 85 km was measured to be 5 rayleighs or less; if energetic particles had produced the 400 R of 5577 Å observed, they should have also produced about 200 R of 3914 Å, or more than forty times what was observed. Second, the altitude profile was measured with high precision and with its (94.5 ± 0.3)-km peak and its (5.8 ± 0.3)-km half-width was much narrower than if produced by particle fluxes of various energy spectra and pitch-angle distributions. Third, the actual particle fluxes were measured and would have produced much less than 1 R of 5577 Å around the altitude where it was brightest. The results therefore prove that less than 3% of midlatitude 5577 Å night airglow can be termed a permanent aurora. The 3914 Å photometer measured 5 R emitted above 85 km, but a zenith-equivalent brightness of 10 R when it viewed the emission edge-on. The difference of 5 R is shown to be just that which would be caused by cosmic radiation at altitudes below 30 km. The particle fluxes are shown to be somewhat less than the precipitated fluxes measured several years previously with satellites. A comment is made on the contamination of some measurements of galactic x rays by such precipitated electrons and vice versa. (auth)

8331 POLARIZATION OF SUDDEN IMPULSES IN THE GEOMAGNETIC FIELD. Sue Ann Bowling and Charles R. Wilson (Univ. of Alaska, College). J. Geophys. Res., 70: 191-7(Jan. 1, 1965).

Sudden impulses in the earth's magnetic field were analyzed by the construction of vector diagrams of the total horizontal disturbance vector ΔH from D and H rapid-run magnetograms for observatories all over the world. At high latitudes the si field was found to be elliptically polarized during the first few minutes of the disturbance. From a comparison of the morphologies of ssc's and si's, it was concluded that si's are also caused by fluctuations in the solar wind energy density and that the perturbations are propagated to the earth's surface by hydromagnetic waves. (auth)

8332 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln, ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 70: 225(Jan. 1, 1965).

A table is given of geomagnetic planetary 3-hr-range indices, preliminary magnetic character figures, magnetic character figures, average amplitudes, Fredericksburg 3-hr-range indices, and provisional sunspot numbers, for the 31 days in August 1964. (M.J.T.)

8333 IN SITU DETECTION OF AN IONOSPHERIC ELECTRIC CURRENT. K. Burrows and S. H. Hall (Imperial Coll. of Science and Tech., London). Nature, 204: 721-2(Nov. 21, 1964).

Data gathered by proton precession magnetometers aboard a high-altitude sounding rocket are analyzed. Results indicate that the rockets passed through an electric current sheet flowing in a direction having a westerly component and of a nature similar to that postulated to account for the daily magnetic variations at ground level. No evidence appeared in support of similar phenomena at higher altitudes. (J.R.D.)

8334 THE VAN ALLEN BELTS. I. F. Delobeau. Nucleus (Paris), 5: 281-9(July-Aug. 1964). (In French)

The discovery and confirmation of the permanent existence of radiation belts, caused by the imprisonment of charged particles in the geomagnetic field, is reviewed. The theories describing the individual movements of the

charges are summarized. The studies made and the data available on the structure of the exterior belt are discussed. (J.S.R.)

8335 TURBULENT EDDY MOTION AND FROZEN-IN FIELD. R. S. Iyengar (Mount Allison Univ., Sackville, Can.). Phys. Letters, 13: 297-8(Dec. 15, 1964).

Turbulent eddy motion is known near the 100 km level by rocket techniques. Its effect during normal periods may not be conspicuous, but, during disturbed periods, the local magnetic field may be influenced by the frozen-in field with eddies in turbulent motion. If this is so, some of the magnetic pulsations observed during disturbed conditions may be explained by the eddy processes in the lower ionosphere, e.g., some of the time scales in the micropulsations. An investigation of the relevant parameters is presented. (C.E.S.)

8336 ACCELERATION OF ELECTRONS NEAR THE EARTH'S BOW SHOCK. J. R. Jokipii and Leverett Davis, Jr. (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 13: 739-41(Dec. 21, 1964).

Pulses of 30- to 50-kev electrons observed in the region of the outer magnetosphere are discussed. It was previously proposed that electrons are accelerated and occur in a thin region at the bow shock outside of the magnetosphere, locating the bow shock at the outermost point where electrons are observed on each orbit. It is concluded that a model interpreting the pulses as thin layers with the outermost layer usually being at the bow shock is unlikely on both theoretical and observational grounds. It is shown that electrons are found beyond the bow shock, and two models of the phenomena are considered. (C.E.S.)

Low Temperature Physics

8337 EFFECT OF ROCKET ENGINE VIBRATION ON AN AIR-CORE SUPERCONDUCTING MAGNET. Leroy J. Krzycki, William M. Byrne, Jr., and James B. Lee (Naval Ordnance Test Station, China Lake, Calif.). J. Spacecraft Rockets, 1: 680-1(Nov.-Dec. 1964).

The behavior of an air-core superconducting magnet in the presence of rocket engine vibration is discussed. It was found that dynamic vibration, caused by combustion and jet effects, can affect the operational stability of a superconducting magnet. (C.E.S.)

8338 DEPENDENCE OF THE CRITICAL CURRENT AND THE MAGNETISATION ON THE RISE-TIME OF THE MAGNETIC FIELD IN SUPERCONDUCTING NIOBIUM–TITANIUM. I. Dietrich and R. Weyl (Siemens and Halske AG, Munich). Phys. Letters, 13: 274-5(Dec. 15, 1964).

The dependence of critical current and magnetization on rise-time of the magnetic field is described. The samples consisted of cold-worked Nb–Ti were with 80 at.% Ti, which was afterwards segregated due to annealing. This intrinsic type II superconductor has a large amount of defects, dislocations, and inhomogeneities and its magnetization curve is irreversible. Such a material is called a type III superconductor. (C.E.S.)

8339 SOME COMMENTS ON THE "SHEATH" THEORY. M. J. Zuckermann (Univ. of Chicago). Phys. Letters, 13: 277-8(Dec. 15, 1964).

It was previously shown that a type II superconductor with an electropolished surface has an upper critical field H_{c3} that is greater than the Abrikosov field H_{c2} by a factor of 1.69 if the magnetic field lies in a direction parallel to the surface, and it was deduced that for a field H such that $H_{c3} > H > H_{c2}$ there is a residual superconducting sheath on the surface of the superconductor. The field distribution and magnetization for a superconducting sheath are found for the case in which H is less than but close to H_{c3}. (C.E.S.)

8340 ON THE VALENCE AND VOLUME DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF TIN ALLOYS. R. I. Gayley (New York State Univ., Buffalo). Phys. Letters, 13: 278-80(Dec. 15, 1964).

A semi-empirical formula that accounts with good precision for part of the variation with alloying of the superconducting transition temperature of tin is presented. The formula is based on an analysis of the low composition variation into three contributions: a mean-free-path effect arising from the smearing out of the anisotropy of the energy gap, an isotropic mean free path effect, and a charge effect. The combined charge and volume effect are taken into account. (C.E.S.)

8341 GUIDED MOTION OF VORTICES IN TYPE II SUPERCONDUCTORS. F. A. Staas, A. K. Niessen, W. F. Druyvesteyn, and J. von Suchtelen (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 13: 293-5(Dec. 15, 1964).

A Hall effect in type II superconductors is considered in connection with the force balance for a moving vortex between a Magnus force and a damping force. The nature of these effects, which were found to be correlated to the structure of the material and which can be explained by a simple model, are discussed. Nb and single phased Pb–In Hall specimens were used. (C.E.S.)

8342 SORPTION OF He^3 BETWEEN 0.6°K AND 4.2°K. D. F. Brewer, A. J. Symonds, and A. L. Thomson (Univ. of Sussex, Eng.). Phys. Letters, 13: 298-300(Dec. 15, 1964).

The adsorption isotherms of ^{3}He on Vycor porous glass between 0.625 and 4.2°K were measured by means of a standard volumetric technique. (C.E.S.)

8343 MATRIX ELEMENTS OF A FERMION SYSTEM IN A REPRESENTATION OF CORRELATED BASIS FUNCTIONS. Eugene Feenberg and Chia-Wei Woo (Washington Univ., St. Louis). Phys. Rev., 137: A391-405(Jan. 18, 1965).

The ground state and low excited states of liquid ^{3}He (and other fermion systems) can be constructed from a set of basis functions $\Psi(|n) = \psi_0^B \Phi(|n)$, in which ψ_0^B is the ground-state boson-type solution of the Schroedinger equation and the model functions $\Phi(|n)$ are Slater determinants suitable for describing states of the noninteracting Fermion system. Diagonal and nondiagonal matrix elements of the identity and the hamiltonian operator are evaluated by a cluster-expansion technique. An orthonormal basis system is constructed from $\Psi(|n)$ and used to express the hamiltonian operator in quasiparticle form: a large diagonal component containing constant, linear, quadratic, and cubic terms in free-quasiparticle occupation-number operators and a non-diagonal component representing the residual interactions involved in collisions of two and three free quasiparticles. (auth)

8344 APPLICATION OF SUM RULES TO THE LOW-TEMPERATURE INTERACTING BOSON SYSTEM. R. D. Puff (Univ. of Washington, Seattle). Phys. Rev., 137: A406-16(Jan. 18, 1965). (TID-20921)

Sum rules satisfied by the density correlation function are applied to the calculation of properties of the interacting Bose system, particularly liquid ^{4}He and the hard-core gas. In addition to the two well-known sum rules previously discussed, a third useful relation which directly involves the two-body interaction is derived. The assumption that a single excitation exhausts all the sum rules (which is known to lead to the Feynman theory when only the first two sum rules are used) now provides, with the help of the additional sum rule, an explicit integral equation for the liquid structure factor S(k). This equation can be solved quite easily for the hard-core gas, and the low-lying excitation spectrum is found to have the form $\omega_{hc}^2(k) = k^2 v_T^2 + (k^2/2m)^2 + 4(k^2/2m)\,[(P/\rho - 2/3\,\langle KE\rangle/\langle N\rangle)\,(\mathscr{S}_1(ka) - \mathscr{S}_1(0)) + (mv_T^2 - 2P/\rho - 2/3\,\langle KE\rangle/\langle N\rangle)\,(\mathscr{S}_2(ka) - \mathscr{S}_2(0))]$, where v_T, P, $\langle KE\rangle/\langle N\rangle$ and a are, respectively, the sound velocity, pressure, kinetic energy per particle, and core diameter. $\mathscr{S}_1$ and $\mathscr{S}_2$ are sinusoidal functions. Although the sum rules themselves are exact, there are several difficulties associated

with the use of the sharp resonance assumption. The consequences of the sharp-resonance approximation are pursued to obtain an integral equation for the liquid structure factor S(k) together with the above closed-form solution for the hard-core gas excitation spectrum. The speculation that the approximation becomes essentially exact in the low-k limit provides, through the third sum rule, an expression for the sound velocity in terms of the two-body potential v(r) and the radial distribution function S(r). This relation is applied to the case of liquid ^{4}He, and extensions of the single-resonance approximation which can be made with the help of the third sum rule are discussed. (auth)

8345 NEUTRON SCATTERING FROM LIQUID ARGON. B. A. Dasannacharya and K. R. Rao (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 137: A417-27(Jan. 18, 1965).

Extensive measurements of slow-neutron inelastic scattering from liquid argon at 84.5°K were made using cold and thermal neutrons. The cold-neutron experiments were performed using a rotating-crystal spectrometer. A triple-axis spectrometer in its constant-Q mode of operation was used for the thermal-neutron measurements. A wave-vector transfer (Q) range of 0.4 to 6.0 $Å^{-1}$ was covered, a range which extends through the third peak in the diffraction pattern of liquid argon. Some data were also collected at 87.9, 90.0, and 92.3°K. The measurements at 84.5°K were converted to Van Hove's $S(Q,\omega)$ which was in turn converted to the intermediate scattering function, I(Q, t), and then to Van Hove's space-time self- and pair-correlation functions. I(Q, t) was determined for $Q \leq 6$ $Å^{-1}$ and $t \leq 6 \times 10^{-12}$ sec. The self-correlation function, $G_s(r, t)$, was completely mapped in the time range $0-2 \times 10^{-12}$ sec and is found to be Gaussian in shape within the experimental error (about 10 to 15%). The width of $G_s(r, t)$ follows the law obtained from assuming Fick's law for diffusion. This fact suggests that diffusion in argon is a simple process, unlike that in other liquids investigated by means of neutrons. This conclusion is supported by measurements on the temperature dependence of the energy width. These measurements give an activation energy of roughly 700 cal/mole for diffusion, in fair agreement with previous measurements on the temperature dependence of the diffusion constant. The time-dependent pair-correlation function was also determined in the time range of $0-2 \times 10^{-12}$ sec. From 2×10^{-12} to 6×10^{-12} sec, a weighted combination of $G_s(r, t)$ and $G_d(r, t)$ is observed. The static pair-correlation function is in agreement with earlier measurements on argon and krypton. (auth)

8346 BEHAVIOR OF QUANTIZED VORTEX RINGS NEAR A WALL. Lothar Meyer and Toshio Soda (Univ. of Chicago). Phys. Rev., 137: A428-31(Jan. 18, 1965).

It is shown that, neglecting frictional forces, a vortex ring does not approach a wall nearer than 0.1 to 0.5 of its radius. This effect can explain the buildup of space charges in front of electrodes observed in experiments with charge-carrying quantized vortex rirgs in He II. (auth)

8347 NONLINEAR REACTANCE OF SUPERCONDUCTING FILMS. J. Gittleman, B. Rosenblum, T. E. Seidel, and A. W. Wicklund (RCA Labs., Princeton, N. J.). Phys. Rev., 137: A527-36(Jan. 18, 1965).

The dependence of the imaginary part of the conductivity (σ_2) on current was measured at various temperatures for films of tin, indium, and tin–indium alloys. The samples were thin, narrow films so that both the d-c and microwave currents were spatially uniform. The reactance of the samples was measured with a small 23-kMc signal while the direct current in the film was varied from zero to the critical value. At reduced temperatures above 0.6, the magnitude and the temperature dependence of the nonlinearity were in remarkably good agreement with both the microscopic theory of Parmenter and the phenomenological Ginsburg-Landau theory. The only adjustable parameter was the penetration depth for each sample. The values chosen for the penetration depth were in excellent agreement with values computed from residual resistance ratios. There was also an indication in the data that the boundary scattering in indium films is highly specular, whereas in the tin films it appears to be diffuse. (auth)

8348 SUPERCONDUCTIVITY IN PURE La AND La–Gd. D. K. Finnemore, D. L. Johnson, J. E. Ostenson, F. H. Spedding, and B. J. Beaudry (Ames Lab., Ames, Iowa). Phys. Rev., 137: A550-6(Jan. 18, 1965). (IS-943)

Superconducting La doped with the magnetic impurity Gd was investigated to determine whether the thermodynamic properties show evidence for gapless superconductivity. The measurements show that the specific heat of pure hcp La closely follows the predictions of the BCS theory. The addition of small amounts of Gd does not appreciably change the normal-state electronic specific heat, but it drastically alters the superconducting characteristics. An increase in the Gd content decreases the rate at which the normalized superconducting specific heat $C_{es}/\gamma T_c$ approaches zero. This effect may be due to a diminishing ratio of the energy of the energy gap to the critical temperature, or it may be due to ordering of the Gd ions. The measurements do not extend to low enough temperatures to distinguish between these two possibilities. The magnitude of the specific-heat jump at T_c is depressed by the Gd somewhat more rapidly than $1.43\gamma T_c$, but less rapidly than is suggested by the electron-tunneling energy-gap measurements. These alloys can support current densities greater than 5×10^4 amp/cm^2, and they show no latent heat at the transition in a magnetic field. The latter two characteristics are qualitatively similar to behavior of type II superconductors. (auth)

8349 EFFECT OF MAGNETIC IMPURITIES ON THE DENSITY OF STATES OF SUPERCONDUCTORS. Michael A. Woolf and F. Reif (Univ. of California, Berkeley). Phys. Rev., 137: A557-64(Jan. 18, 1965).

The technique of electron tunneling was applied to a systematic study of the density of states in superconductors containing magnetic impurities. Whereas earlier experiments on such superconductors examined the current-voltage tunneling characteristics at 1°K, the present experiments were refined so as to measure directly the tunneling conductance, and hence the density of states, down to 0.4°K. The present data can therefore be compared with the predictions of the Abrikosov-Gorkov theory worked out in detail by Skalski, Betbeder-Matibet, and Weiss. Qualitatively, the addition of magnetic impurities causes a reduction of the energy gap and a broadening of the peak in the density of states. The detailed shape of the density-of-states curves agrees reasonably well with the theory, at least for a rare-earth impurity system like Gd in lead. The transition-element impurities Fe (in indium) and Mn (in lead) have a more pronounced effect than predicted, the energy gap being substantially more filled in and less well defined than in the Pb–Gd system. Experiments on pure superconducting films with superimposed layers of magnetic metal atoms yield similar effects on the density of states. The experiments indicate that it is the presence of strong correlations between electrons rather than the existence of a well defined energy gap which is the essential feature of the superconducting state. (auth)

8350 RELEVANCE OF HELMHOLZ FLOW TO SUPERFLUID HYDRODYNAMICS. Paul P. Craig (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 708-10(Dec. 14, 1964).

Studies of superfluid He II using Rayleigh-disk experiments are interpreted in terms of Helmholz flow equations. (T.F.H.)

8351 SUPERCONDUCTIVITY OF SODIUM TUNGSTEN BRONZES. Ch. J. Raub, A. R. Sweedler, M. A. Jensen, S. Broadston, and B. T. Matthias (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 13: 746-7(Dec. 21, 1964).

Evidence is presented for the superconductivity of sodium tungsten bronzes. The transition temperatures are in the range below 1°K. (C.E.S.)

8352 MOTION OF QUANTIZED FLUX LINES IN SUPER-CONDUCTORS. J. Bardeen (Univ. of Illinois, Urbana). Phys. Rev. Letters, 13: 747-8(Dec. 21, 1964).

It was previously argued that in a superconductor a flux line moving with velocity $\vec{v}_L$ should be subject to a force $\vec{F}_L = Ne\Phi(\vec{v}_L \times \vec{n})$, where N is the electron concentration, Φ is the total flux, $\vec{n}$ is a unit vector along its direction, and units are taken such that c = 1. This force is presumed to be analogous to the Magnus force acting on a vortex line moving in a liquid. Such a force would give rise to vibrational modes, a large Hall angle for current flow in type-II superconductors, and other effects. There is considerable experimental evidence that no such force exists. It is pointed out that the theoretical arguments given for such a force are in error. (C.E.S.)

8353 SUPERCONDUCTIVITY IN MACROSCOPIC ONE-DIMENSIONAL SYSTEMS. R. E. DeWames, G. W. Lehman, and T. Wolfram (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev. Letters, 13: 749-50 (Dec. 21, 1964).

The possibility of superconductivity in long-chain organic macromolecules is considered. The Gorkov function $F(x) = \Delta\langle e^{i\varphi(x)}\rangle = \Delta e^{-M}$ where $M = G^2/(2mnL\hbar)\,\Sigma_k\, 1/\omega_k\,(\langle N_k\rangle + \frac{1}{2}) = G^2/(4\pi mnv\hbar)\int dk/k$, for T = 0 is discussed. It is shown that e^{-M} is nonzero for finite systems, and the dependence of M on the size of the system is examined. (C.E.S.)

8354 ION TRAPPING IN ROTATING HELIUM II. R. L. Douglass (American Univ. of Beirut). Phys. Rev. Letters, 13: 791-4(Dec. 28, 1964).

The direct detection of trapped negative ions in rotating He II is reported. Measurements of their mean trapped time and of their mobility parallel to the rotation axis at temperatures between 1.20 and 1.72°K are presented. (C.E.S.)

8355 DISSIPATIVE MECHANISM IN TYPE-II SUPER-CONDUCTORS. A. R. Strnad, C. F. Hempstead, and Y. B. Kim (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Letters, 13: 794-7(Dec. 28, 1964).

The dissipative mechanism associated with the motion of flux lines in type-II superconductors is discussed. Measurements of the voltage vs current characteristics and flow resistivity vs H and T in Nb–Ta and Pb–In alloys are presented. A relation, which appears to manifest a very basic dissipative mechanism in type-II superconductors, is derived. The question of Hall voltages in type-II superconductors is also considered. (C.E.S.)

8356 WEAK TIME DEPENDENCE IN PURE SUPER-CONDUCTORS. M. J. Stephen and H. Suhl (Univ. of California, San Diego, La Jolla). Phys. Rev. Letters, 13: 797-800(Dec. 28, 1964).

The equilibrium properties of type-II superconductors are successfully explained by the Ginzburg-Landau theory. In this theory the state of the superconductor is characterized by an order parameter (energy gap), and an electromagnetic field, both varying with position. One expects a similar characterization to hold also for certain restricted types of time variations, especially if these are slow enough to preclude breakup of Cooper pairs. Because of the time dependence, there appears to be no obvious way of basing such a theory on thermodynamics alone. Therefore the BCS model in the Gorkov formulation is used to derive the necessary time-dependent generalizations. The theory is restricted to pure superconductors. (C.E.S.)

8357 VISCOUS FLOW OF FLUX IN TYPE-II SUPER-CONDUCTORS. M. Tinkham (Univ. of California, Berkeley). Phys. Rev. Letters, 13: 804-7(Dec. 28, 1964).

The origin of the viscous drag coefficient in the flow of flux in type-II superconductors is discussed. (C.E.S.)

8358 ISOTOPIC MIXTURES OF SOLID HELIUM. P. G. Klemens, R. De Bruyn Ouboter, and C. Le Pair (Kamerlingh Onnes Laboratorium, Leiden). Physica, 30: 1863-71(Oct. 1964).

On the assumption that the energy of solid helium is composed additively of the energies of individual atomic cells, that the latter consists of a zero-point energy, a lattice potential and a pressure term, and that the zero-point energy varies inversely as the mass of the atom, it is possible to obtain expressions for the distortion of the lattice around an isotopic impurity, and for the heat of mixing of isotopes of solid helium, in terms of the difference in atomic volume of the two pure solid components and of their elastic constants. It is estimated that at 30 atm the radial distortion around an isotope is 3%, and the heat of mixing is given by $H^E = X(1 - X)\,E_M$, where X is the concentration of one species and $E_M/R = 0.75°K$. The observed value of E_M/R is 0.76°K. Both the distortion and the heat of mixing should decrease with increasing pressure. (auth)

8359 THE ATTENUATION OF HIGH FREQUENCY PHONONS AT LOW TEMPERATURES. R. Orbach and L. A. Vredevoe (Univ. of California, Los Angeles). Physics, 1: 91-4(Sept.-Oct. 1964).

Anharmonic attenuation of phonons with energies $\hbar\omega \gg kT$ is considered. The attenuation of a high-energy phonon at low temperatures was examined theoretically for attenuation via three- and four-phonon anharmonic processes. It is found, as a consequence of energy-momentum conservation conditions, that the lowest (transverse) branch of the phonon spectrum has an anomalously long lifetime at low temperatures, proportional to $\exp(a\hbar\omega/kT)$, where a is a constant of order unity. This phenomenon is in marked contrast with the much faster relaxation rates for the other two branches. (M.J.T.)

8360 MAGNETIC BEHAVIOR OF VERY SMALL SUPERCONDUCTING PARTICLES. P. G. de Gennes and M. Tinkham (Universite de Paris, Orsay, France). Physics, 1: 107-26(Sept.-Oct. 1964).

The critical field of superconducting particles or films much smaller than the coherence length and the penetration depth is discussed. Situations are considered where the order parameter is constant in space and where the superconducting transition in the presence of the field is of second order. The critical field calculation is reduced to a study of the magnetic flux ϕ enclosed by all one-electron trajectories in the normal state during a prescribed time interval. It is shown that (1) if ϕ does not have a completely ergodic behavior at large times, the equation of state is of the BCS type, but with a renormalized, field dependent coupling constant $N(0)V\,\eta(H)$, and that (2) if ϕ has a certain ergodic property, the effect of the field is comparable to the effect of paramagnetic impurities. A region of gapless superconductivity is present in the (HT) plane. A thin film in a parallel field with diffuse boundary scattering but no volume defects belongs to case (1). A small amount of scattering in the bulk is enough to restore case (2). Numerical values of the resulting critical field are discussed in detail for various ratios of the bulk mean free path to the film thickness d. In the situations of major physical interest the theoretical values are proportional to $d^{-\frac{1}{2}}$ and are in rather good agreement with the experimental data. (auth)

8361 THE MAGNETIC PROPERTIES OF SUPER-CONDUCTING ALLOYS. [PART] II. Kazumi Maki (Kyoto Univ.). Physics, 1: 127-43(Sept.-Oct. 1964).

The lower critical field H_{c1} is derived from the microscopic theory for superconducting alloys. It is shown that Abrikosov's structure in the field just above H_{c1} is described by the use of a parameter from which the temperature dependence is obtained. A brief discussion of the gap in the excitation spectrum and the thermodynamical behavior at lower temperatures is given. The effect of the Pauli paramagnetism on the magnetic properties of superconducting alloys is investigated in detail. It is shown that Abrikosov's structure is still described completely by the use of two parameters $\kappa_1^*(T)$ and $\kappa_2^*(T)$ in the vicinity of the transition point when the phase transition is of the second order. In superconductors having a large Pauli term $(3\mu/e\tau_{tr}v^2) \geq 1.475$, where μ is the Bohr magneton, τ_{tr} the transport collision time of an electron, and v the fermi

velocity, the order of the transition is found to change from the second to the first as temperature decreases. (auth)

8362 THERMODYNAMIC PROPERTIES OF SUPERCONDUCTING AND NORMAL MOLYBDENUM. David Cooke Rorer. Thesis, Durham, N. C., Duke Univ., 1964. 124p.

The specific heat capacities of two samples of ultrapure molybdenum were measured over the temperature range from 0.35 to 4.0°K. Superconducting transitions were found to take place in zero magnetic field at temperatures of 0.915 and 0.918°K, where the difference in specific heats ($C_s - C_n$) was found to be 2.22 ± 0.07 and 2.19 ± 0.10 millijoules/mole-degree, respectively. High-resolution measurements on one sample showed that the zero-field transition was complete in 3.8 millidegrees. Calorimetrically determined critical field curves yielded values of $(dH_c/dT)_{H=0}$ equal to −180 ± 4 and −178 ± 5 gauss/degree K for the two samples. Extrapolation of these curves to T = 0°K gave values for H_0 equal to 98 ± 5 gauss and 100 ± 5 gauss, respectively. Somewhat lower values of the specific heat constants for the normal metal, γ and θ_D, were found than previously reported for molybdenum, although all experimental quantities measured here were found to be thermodynamically consistent. A low-temperature deviation of the specific heat for molybdenum from the theoretical values predicted by Bardeen, Cooper, and Schrieffer suggested the presence of either a very anisotropic energy gap or the existence of two energy gaps, as obtained theoretically for the transition element superconductors by Garland. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8363 THE THERMAL CONDUCTIVITY OF LEAD AND MERCURY CLOSE TO THEIR SUPERCONDUCTING TRANSITION TEMPERATURES. James Henry Peter Watson. Thesis, Toronto, Univ. of Toronto, 1963. 99p.

Measurements of the thermal conductivity in the superconducting state k_s and in the normal state k_n of mercury and lead were made near T_c, the transition temperature, using temperature differences of the order of 10 millidegrees, in order to resolve as accurately as possible the behavior of k at the transition. The general form of the results is similar to that reported by other workers, but the measurements do indicate higher values of k_s/k_n in these materials than reported previously, about 1% for lead and 2% for mercury. An attempt is made to reconcile these results with the predictions of Kadanoff and Martin by introducing the temperature variation of the Debye temperature H_D (from specific heat results) into the Bardeen, Cooper, and Schrieffer expression for T_c. The analysis shows that the variation of H_D could produce deviations from the ideal behavior of the same order as the observed deviations of k_s/k_n in mercury and lead from the theoretical prediction. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8364 THE GROUND STATE OF LIQUID HELIUM-FOUR. William Lauchlin McMillan. Thesis, Chicago, Univ. of Illinois, 1964. 49p.

The properties of the ground state of liquid He^4 are studied using a variational wave function of the form $\Pi_{i<j} f(r_{ij})$. The Lennard-Jones 12-6 potential with parameters determined from the gas data by de Boer and Michels is used. The configuration space integrals are performed by the Monte Carlo method of Metropolis et al., for 32 and 108 atoms in the periodic cube. With $f(r) = \exp(-(2.6A/r)^5)$ the ground state energy is found to be -0.781×10^{-15} ergs/atom which is 20% above experimental value. The liquid structure factor and the two-particle correlation function are in reasonable good agreement with the x-ray and neutron scattering experiments. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8365 ELECTRON TUNNELING INTO SUPERCONDUCTING MERCURY FILMS. Stuart Bermon. Thesis, Chicago, Univ. of Illinois, 1964. 137p.

Tunneling measurements were made on junctions consisting of evaporated films of aluminum and mercury separated by an aluminum oxide insulating layer. The evaporations took place inside a chamber housed in the bottom of a helium dewar. The width of the superconducting mercury energy gap extrapolated to T = 0°K was determined to be $2\Delta(0) = (1.65 \pm 0.03) \times 10^{-3}$ ev $\simeq (4.6 \pm 0.1)k_B T_c$ from the current-voltage characteristic with the junction in the superconductor-insulator-superconductor configuration. Comparison is made with theory and with thermodynamic and spectroscopic measurements of the gap. Measurements of the differential conductance in the vicinity of the gap in the metal-insulator-superconductor junction show qualitative agreement with curves calculated from a BCS density of states, although the experimental curves are more peaked and have a larger tail at low bias voltages. The temperature dependence of the gap, as determined by the differential conductance at zero bias, was found to agree closely with the BCS variation provided that the BCS curve is scaled by a constant multiplier. Structure thought to be related to the phonon spectrum of mercury was observed at higher biases in the first and in the second derivative of the tunneling current. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8366 THE INFLUENCE OF FIBER STRUCTURE ON THE SUPERCONDUCTING BEHAVIOR OF COLD-ROLLED COLUMBIUM. D. Kramer and C. G. Rhodes (North American Aviation Science Center, Thousand Oaks, Calif.). 32p. (CONF-524-15)

From American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964.

High field critical transport current density (J) measurements at 4.2°K as a function of applied magnetic field (H) were made on samples of cold-rolled and annealed Nb with H parallel to J. Microscopic examination of the samples revealed a well defined planar fiber structure produced by the cold-rolling. J was found to be lower when fibers are parallel to the direction of magnetic field penetration than when they are perpendicular. This effect may be a consequence of the interaction of flux movement with fiber boundaries. (auth)

8367 A STUDY OF THE LAMINAR AND TURBULENT FLOW OF He II IN TWO CLOSED OSCILLATING GEOMETRIES. Stephen Knight (Bell Telephone Labs., Inc., Murray Hill, N. J.) and John D. Reppy. 12p. (CONF-651-25)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The hydrodynamics of He II were investigated in previously unexplored regions of amplitude and period. Data obtained with two different containers indicate that classical hydrodynamics can be used to explain the normal component. Results for these containers, obtained for the region above the superfluid critical velocity, show nearly complete coupling of the total liquid. Vortex wave phenomena were observed and are discussed. (J.R.D.)

8368 EFFECT OF MAGNETIC FIELDS ON ENERGY GAP OF SUPERCONDUCTORS. Kazumi Maki (Kyoto Univ.). 11p. (CONF-651-21)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Assuming that the electronic mean free path is very short ($l/\xi_0 \ll 1$ where l is the electronic mean free path and ξ_0 the coherence length of the electron pair) and that the ordering parameter Δ is constant all over the specimen, the general Gor'kov equation is solved for cases involving the presence of magnetic fields. The effect of magnetic fields on superconductivity is found to be equivalent to that of paramagnetic impurities. More general situations in dirty superconductors are also studied. A generalization of Ginzburg Landau equation valid in all temperatures is obtained. (auth)

8369 SEARCH FOR A MAGNETICALLY ORDERED STATE OF ADSORBED He^3. Harold Weinstock and Christopher E. Long (Michigan State Univ., East Lansing). 6p. (CONF-651-20)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

An attempt to determine the magnetic properties of ^3He adsorbed on 13X zeolite molecular sieves by nuclear magnetization and by search for magnetic field dependence to

a reported specific heat anomaly is discussed. It is concluded that the specific heat anomaly is not due to magnetic ordering. (J.R.D.)

8370 DISTINCTIVE PROPERTIES OF QUANTIZED VORTICES IN SUPERCONDUCTING FILMS. J. Pearl (RCA Labs., Princeton, N. J.). 10p. (CONF-651-23)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

A model for the magnetic properties of thin superconducting films is presented. The current distribution and pair interaction forces for individual fluxoids are derived and these results are used to determine the macroscopic behavior of thin films in the presence of magnetic fields. (J.R.D.)

8371 EXPERIMENTAL RELATIONS FOR ELECTRON-INTERACTIONS IN TRANSITION METALS, DETERMINED FROM SUPERCONDUCTIVITY DATA. E. Bucher (Université, Geneva), F. Heiniger, J. Muller, and J. L. Olsen. 13p. (CONF-651-26)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Refinements of the theory (BCS theory) that correctly predicts most superconductor thermodynamic properties are presented for use in superconductivity occurrence prediction. These refinements are required to account for specific parameters characteristic of given materials. Data on the energy dependence of the gap parameter are included. (J.R.D.)

8372 ANOMALOUS ELECTRON SCATTERING IN DILUTE MAGNETIC ALLOYS. S. H. Liu (International Business Machines Corp., Yorktown Heights, N. Y.). 34p. (CONF-651-32).

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The Kondo theory of resistance minimum was extended to show that the resistance anomaly is not affected by nonmagnetic scatterings, the magneto-resistance shows a logarithmic field dependence under strong fields and low temperatures and the anomalous scattering affects the superconducting properties of the alloy in nearly the same way as the normal scattering. So the theory based on normal scattering is still qualitatively correct. (auth)

8373 WEAK SUPERCONDUCTIVITY: THE JOSEPHSON TUNNELING EFFECT. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.). 35p. (CONF-651-36).

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

Josephson predicted theoretically that a supercurrent would flow in tunneling through an insulating barrier between two superconductors. The current would be d-c at zero voltage difference but otherwise a-c. An elementary mathematical theory of the effect based on calculating the energy coupling the phases of the gaps on the two sides is given. The observability of the two effects is discussed, and the importance of the effect to the general theory of condensation and broken symmetry is shown. (auth)

Neutron Physics

8374 (AE-164) THE SOLUTION OF A VELOCITY-DEPENDENT SLOWING-DOWN PROBLEM USING CASE'S EIGENFUNCTION EXPANSION. Arne Claesson (Aktiebolaget Atomenergi, Stockholm). Nov. 1964. 19p. Dep. (mn).

The slowing-down of neutrons in a hydrogenous moderator is calculated, assuming a plane source of monoenergetic neutrons. The scattering is regarded as spherically symmetric, but it is shown that a generalization to anisotropy is possible. The cross section is assumed to be constant. The virgin neutrons are separated out, and it follows that the distribution of the remaining neutrons can be obtained by using an expansion in the eigenfunctions for the velocity-independent problem. (auth)

8375 (BNL-7645) MAGNETIC INELASTIC SCATTERING OF NEUTRONS DETERMINED FROM THE TOTAL CROSS SECTIONS OF MnO AND $Mn_{0.5}Zn_{0.5}Fe_2O_4$ AS A FUNCTION OF TEMPERATURE. A. M. Kistner and T. I. Taylor (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-2)-Gen-16. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The magnetic inelastic cross section was determined for MnO from 298 to 78°K and for $Mn_{0.5}Zn_{0.5}Fe_2O_4$ from 507 to 78°K, using 11.5-Å neutrons. The incoherent approximation for the cross section equation, using the Brillouin function and assuming long-range ordering alone, did not account for the cross section contribution for MnO. The disagreement for MnO is attributed to additional order below the Néel point. For MnO, data over the magnetic Bragg maximum are presented which describes the variation with wavelength and with temperature of that part of the inelastic scattering which may be attributed to fluctuations in magnetization in the critical temperature region. It is shown that for MnO critical scattering exists only for a short interval of neutron wavelengths, at most ±0.4 Å about the (111) superlattice peak at 10.15 Å. The cross section variation with temperature for $Mn_{0.5}Zn_{0.5}Fe_2O_4$ at 11.5 Å also showed no appreciable critical scattering at a neutron wavelength difference from the superlattice reflection of 1.5 Å. (auth)

8376 (GA-5176) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending March 31, 1964. J. R. Beyster, J. R. Brown, J. U. Koppel, J. M. Neill, J. R. Triplett, J. A. Young, and J. C. Young (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 17, 1964. Contract AT(04-3)-167. 75p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Activities in programs to develop scattering models for the common reactor moderators are reported. Activities directed toward generating scattering kernels based on these models and those directed toward comparison of model predictions with experimental results are also reported. (J.R.D.)

8377 (ORNL-TM-987) DESIGN ANALYSIS OF A PURE FISSION SPECTRUM FACILITY FOR THE BULK SHIELDING REACTOR. G. H. Llewellyn (Oak Ridge National Lab., Tenn.). Jan. 1965. Contract W-7405-eng-26. 55p. Dep.(mm); $3.00(cy), 2(mn) OTS.

An essentially pure fission spectrum is needed to provide a standard irradiation spectrum for neutron-damage experiments. The preliminary design for such a facility is presented and analyzed for critical power levels under pertinent coolant flow conditions. The proposed facility is designed for installation adjacent to the Bulk Shielding Reactor, and is to be used for neutron damage studies in solids. (auth)

8378 (TID-21429) RESPECT—RENSSELAER STEADY-STATE SPECTRA. R. L. Hobson (Rensselaer Polytechnic Inst., Troy, N. Y.). Nov. 1964. Contract AT (30-3)-328. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A Fortran II program has been prepared to solve the infinite medium homogeneous Boltzmann equation for the neutron number density in the steady state condition. This is accomplished through the use of the discrete ordinates method. The problem is put in matrix form and the solution obtained by the process of matrix inversion. The program allows the use of an arbitrary source and arbitrary absorption cross section. This means that a finite medium may be accounted for in the diffusion approximation by adding a DB^2 to the absorption cross section. This program is of an experimental nature, and no guarantee is given that it is economical in the sense of memory used or time required to run, as one might expect in a polished production code. (auth)

8379 (UCRL-7611(Rev.I)) CRYSTAL REFLECTIVITY AND REACTOR SPECTRUM MEASUREMENTS. Ian R. Jones (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 9, 1963. Contract W-7405-eng-48. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The equations commonly used to calculate the integrated reflectivity of single crystals are shown to be deficient in two respects. The angular divergence of the neutron beam is shown to influence the integrated reflectivity of the crystal in a manner similar to that of the mosaic spread of the crystal; hence the beam cannot be considered parallel. The effective absorption coefficient for neutrons in a single crystal is shown to be poorly approximated by the total macroscopic cross section at thermal energies. The influence of both corrections on the magnitude and shape of reactor spectra is discussed and appropriately modified equations are presented. (auth)

8380 ORTHOGONALITY OF CASE'S EIGENFUNCTIONS IN ONE-SPEED TRANSPORT THEORY. I. Kuscer, N. J. McCormick, and G. C. Summerfield (Univ. of Michigan, Ann Arbor). Ann. Phys. (N. Y.), 30: 411-21(Dec. 1964).

The eigenfunctions of the one-speed transport equation, as introduced by Case, are shown to have more general orthogonality properties than previously known. In particular, for isotropic scattering, partial range and two-media orthogonality relations are derived. An extension of linearly anisotropic scattering is indicated. These results facilitate the application of Case's method to one-speed transport problems in plane geometry. (auth)

8381 THE AGE OF ^{235}U FISSION NEUTRONS IN MONOISOPROPYLDIPHENYL AND IN DIPHENYL-IRON AND DIPHENYL-ALUMINUM. L. N. Yurova, A. A. Polyakova, and A. A. Ignatov. At. Energ. (USSR), 17: 303-4(Oct. 1964). (In Russian)

Density distributions of ^{235}U fission neutrons thermalized to 1.46 ev in monoisopropylbiphenyl were measured for point and extended sources, target thicknesses of 1.8 and 0.3 mm, and source-target distances from 0 to 70 cm, using In foil detectors. The neutron age was calculated from the experimental results, extrapolating to zero thickness. The age value was in good agreement with values from theoretical calculations, using a previously developed fission-spectrum formula and a multigroup calculation. Analogous experiments and calculations were carried out for biphenyl-Fe and biphenyl-Al mixtures. The theoretically obtained values were found to be significantly lower than the experimental ones. (M.J.T.)

8382 ANGULAR AND ENERGY DISTRIBUTION OF NEUTRONS AT THE INTERFACE OF TWO MEDIA. V. A. Dulin, V. G. Dvukhsherstnov, Yu. A. Kazanskii, and I. V. Shugar. At. Energ. (USSR), 17: 486-92(Dec. 1964). (In Russian)

The angular and energy distributions of 0.4- to 3.4-Mev neutrons at water interfaces with graphite, aluminum, iron, nickel, and lead were measured after 1.5 to 4.6 free-path lengths. The reaction $D(d,n)He^3$ was used as a neutron source. Measurements were carried out with a single-crystal scintillation spectrometer with γ discrimination. The experimental data were correlated with theory. (tr-auth)

8383 GENERALIZATION OF THE VARIATIONAL METHOD OF KAHAN, RIDEAU, AND ROUSSOPOULOS AND ITS APPLICATION TO NEUTRON TRANSPORT THEORY. Morton D. Kostin (Princeton Univ., N. J.) and Harvey Brooks. J. Math. Phys. (N. Y.), 5: 1691-1700(Dec. 1964).

The variational method of Kahan, Rideau, and Roussopoulos (KRR) frequently used in neutron transport theory to estimate weighted averages is extended and generalized. In the KRR variational method a first variation in the trial functions produces a second variation in the estimate of the weighted average. Two generalized variational functionals which depend on trial operators instead of trial functions are given. A first variation in the trial operators produces an nth variation in the estimate of the weighted average when an nth order generalized variational functional is used. Both perturbation theory and the KRR variational method are derived as special cases of the generalized variational method. Several examples including calculations of transport equation spatial moments using diffusion equation solutions as trial operators are studied with good results. (auth)

8384 MEASUREMENT OF Pu–Be NEUTRONS WITH ACTIVATION DETECTORS. I. Heertje, N. P. Van Westen, and A. H. W. Aten, Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 30: 1846-8(Oct. 1964).

Activation experiments with neutron threshold detectors were performed in the neutron-flux of a Pu–Be source. It is concluded that about 25% of the neutrons of an 80 g Pu–Be source are emitted with energies below 1 Mev, and that the cross sections available for the detectors used are sufficiently accurate to serve as a basis for measurements of neutron flux densities. (auth)

8385 ON FUNDAMENTAL EQUATIONS OF SPATIALLY INDEPENDENT PROBLEMS IN NEUTRON THERMALIZATION THEORY. Yasushi Shizuta (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 489-511 (Oct. 1964).

The linearized Boltzmann equation describing the velocity distribution of neutrons in an infinite monatomic gas is studied in the framework of the theory of Hilbert space. The corresponding eigenvalue problem is also investigated. It is found that the set of all eigenfunctions does not form a complete set. This result is contrary to the anticipation which seems to have existed widely up to date. The more precise nature of the spectrum is examined by means of the perturbation theory of operators in Hilbert space. Especially the essential spectrum and the absolutely continuous part of the spectrum are determined completely. The asymptotic behavior of the solution of the time-dependent equation is stated as a consequence of our results on the spectrum. Proofs are mathematically rigorous and any argument of heuristic or inconclusive character is avoided. Finally a conjecture on the eigenfunction expansion formula is stated. (auth)

8386 SCATTERING OF NEUTRONS IN DISORDERED CRYSTALS. I. A. Privorotskii. Zh. Eksperim. i Teor. Fiz., 47: 1544-9(Oct. 1964). (In Russian)

Inelastic scattering of neutrons involving the emission of a localized phonon or spin wave is investigated. It is shown that the differential cross sections for these processes are proportional to the spectral density $\nu(\omega,c)$ in the impurity band (ω is the frequency of the emitted quantum). This conclusion does not depend on the features of the classification of localized states. (auth)

8387 INELASTIC SCATTERING OF SLOW NEUTRONS BY ORGANIC MODERATORS. W. Glaeser. Thesis, Karlsruhe, Ger., Technische Hochschule, 1964. 66p. $2.00(Gmelin, AED-DISS. 64-36). (In German)

A double spectrometer with a rotating monochromator crystal and an arrangement for simultaneous time-of-flight measurements in several directions is described. Results of scattering experiments with benzene, biphenyl, and Dowtherm A for neutron energies between 0.0187 and 0.0787 ev are given. Differential scattering cross sections and scattering laws were deduced and compared with theoretical data. Using an extrapolation method from the scattering laws a calculation of generalized frequency distributions was made that is characteristic for the dynamic behavior of the studied systems. (Gmelin Inst.)

8388 DAMPING THEORY AND ITS APPLICATION TO THE INTERPRETATION OF SLOW NEUTRON SCATTERING EXPERIMENTS. Ziyaeddin Ahmet Akcasu. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 73p.

The damping theory, which includes the decay of quantum states, is developed in terms of the projection operators. The concept of probability that a transition from a given initial state will be toward a specified final state is introduced, and the probability is calculated by using the damping theory. When the decay of the final state is neglected, this probability reduces to the conditional probability, introduced by Heitler, that the system will be found in a specified final state after a transition from the given initial state has definitely taken place. With this new probability concept, an ap-

proximate expression is obtained for the transition probability per unit time from the initial to the final state. This expression is the starting point of the present line shape theory, which is applicable to both neutron and photon spectra. In this work, only the scattering of slow neutrons by an anharmonic crystal is considered. The differential scattering cross section formula is obtained first for an arbitrary macroscopic medium, and then applied to a crystal. The cross section formula in the harmonic approximation follows from the present cross section formula when the width and shift of lines are neglected. The novel feature of this derivation is that it does not use Bloch's theorem. Explicit formulas for the width and the shift of the observed peaks in the energy spectrum of the inelastically scattered slow neutrons by crystals are obtained, and compared in the case of a single-phonon event to those by Maradudin and Fein. It is found that the shift formulas agree exactly at all temperatures, whereas the width formulas agree only in the zero temperature limit. The discrepancy in the width formulas at finite temperatures is discussed in terms of the concept of phonon lifetime. The application of the present line shape theory to the interpretation of the optical experiments is also discussed. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8389 TIME-DEPENDENT ONE-SPEED ALBEDO PROBLEM FOR A SEMI-INFINITE MEDIUM. I. Kuščer and P. F. Zweifel (Univ. of Michigan, Ann Arbor). 23p. (CONF-446-48)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

A Laplace transformation technique is used to determine the neutron distribution in a semi-infinite medium irradiated by a neutron pulse. The result is given in terms of known solutions of Milne's problem and of the steady-state albedo problem, which in turn are expressed using Case's X-function. Simple asymptotic approximations, valid for $t \gg 1$, are deduced from the exact result. (auth)

Nuclear Properties and Reactions

Refer also to abstracts 7782, 7796, 8137, and 8670.

8390 (AEEW-M-347) CHECK — AN IBM 7030 S2 (FORTRAN) PROGRAMME FOR CHECKING THE SELF-CONSISTENCY OF NEUTRON CROSS-SECTION DATA IN THE U.K.A.E.A. NUCLEAR DATA LIBRARY. L. W. Blott (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England) and K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). July 1964. 34p. Dep.; $0.90(BIS), 4s. 6d.(HMSO).

A description is given of the main features of CHECK. The report is intended as a guide to the program user. (auth)

8391 (COO-1428-6) THE HIGH-ENERGY PHOTODISINTEGRATION OF He^4. J. G. Asbury and F. J. Loeffler (Purdue Univ., Lafayette, Ind. Physics Dept.). [1963]. Contract [AT(11-1)-1428]. 27p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The two body photodisintegration of ^4He into two deuterons was observed for average photon energies of 221 and 265 Mev. The forward deuteron was detected at a laboratory angle of 45°. Absolute differential cross sections for the process were determined and total cross sections, assuming a $\sin^2\theta \cos^2\theta$ angular distribution, were calculated and compared with upper limits on the cross section for the inverse process, $d + d \rightarrow {}^4He + \gamma$. The results were also compared with theoretical estimates for the cross sections using two different wave functions to describe the ^4He ground state. Data were also obtained for photoproton emission from ^4He. These results were compared with previous measurements and were seen to be consistent with the quasi-deuteron theory of photodisintegration. (auth)

8392 (IS-993) A COMPUTER METHOD FOR DETERMINING BY LEAST SQUARES GAMMA RAY RELATIVE INTENSITIES USING A BENT-CRYSTAL MONOCHROMATOR. Joseph Emerson Brown and E. N. Hatch (Ames Lab., Ames, Iowa). Aug. 1964. Contract W-7405-eng-82. 73p. Dep.; $3.00(OTS).

A method of measuring gamma-ray relative intensities was developed that used a germanium bent-crystal spectrometer as a monochromator. The response function of a NaI detector to the essentially monoenergetic gamma rays, obtained from the diffracted beam of the spectrometer, was recorded in a multichannel analyzer. The composite spectrum due to all the gamma rays was then recorded in the analyzer. A computer program is written to normalize the response functions to unit area and to determine, by minimizing the sum of the squares of the deviations, the linear combination of monoenergetic response functions that best represents the composite spectrum. The intensity of a gamma ray is then proportional to the adjusted area under the monoenergetic response function. The relative intensities of the gamma rays of ^{169}Tm obtained by electron capture from ^{169}Yb were measured. (auth)

8393 (ISS-64/24) DISTRIBUZIONE DEI MOMENTI DEL PROTONE NEL DEUTERIO CALCOLATA CON IL METODO DI MONTECARLO. (Distribution of Momenta of the Proton in the Deuteron Calculated by a Monte Carlo Method). G. Farchi and A. Reale (Italy. Istituto Superiore di Sanita, Rome). June 20, 1964. 20p. Dep.(mn).

The solutions of the non-relativistic Schrödinger equation for the deuteron are examined in momentum space, for some static spherical potentials in coordinate space. By a Monte Carlo method, 10,000 momenta are extracted at random, according to a convenient proton momentum distribution. Some information is also given concerning the momentum distribution of nucleons in light nuclei. For the random extraction of the momenta a program has been written in FORTRAN IV for the IBM 7040 computer. (auth)

8394 (ISS-64/27) PROGRAMMA PER IL CALCOLO DELLA CINEMATICA DI UNA REAZIONE A DUE CORPI (CALCOLATORE ELETTRONICO IBM 7040). (A Program for Calculating the Kinematics of a Two-Body Reaction (IBM 7040 Electronic Computer)). G. Campos Venuti and D. Giucci (Italy. Instituto Superiore di Sanita, Rome). July 10, 1964. 155p. Dep.(mn).

A program is described for calculating the kinematics of a two-body reaction with a target at rest. Three variables, each characterized by different input parameters, allow the calculation of energies, angular distributions, and angular correlations between reaction products. The program has been compiled in double-precision MAP for the IBM 7040. (auth)

8395 (ISS-64-31) A SOLUBLE THREE-CHANNEL MODEL FOR DIRECT NUCLEAR REACTIONS. L. Indorato and G. Papini (Italy. Istituto Superiore di Sanita, Rome). July 25, 1964. 21p. Dep.(mn).

A field-theoretical model is presented, which is suitable for the description of direct nuclear reactions. A method is given for solving the model exactly and for constructing off-shell transition amplitudes and relations among them. Some simple approximations are also derived. (auth)

8396 (ISS-64/35) SULL'EMISSIONE DI NEUTRONI DA PARTE DEI FRAMMENTI DI FISSIONE. (On the Emission of Neutrons from the Fission Fragments). G. Matthiae (Italy. Istituto Superiore di Sanita, Rome). Sept. 8, 1964. 9p. Dep.(mn).

The statistical model of the nuclear reactions has been applied to the spontaneous fission of ^{252}Cf. The number of neutrons emitted from each fragment is calculated as a function of the fragment mass. The resulting distribution, which is in good agreement with the experimental data, reproduces the discontinuity observed at $A = 125$. This discontinuity is correlated with the decrease of the nuclear level density at the neutron magic number 82. (auth)

8397 (JINR-P-1811) KVAZICHASTICHNAYA I KOLLEKTIVNAYA STRUKTURA SOSTOYANII CHETNYKH DEFORMIROVANNYKH YADER. (Quasi-Particle and Collective Structure of the States of Even Deformed Nu-

clei). V. G. Solovev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 50p. Dep.(mn).

The structure of the non-rotational excited states of even deformed nuclei in the ranges $150 \leq A \leq 186$ and $228 \leq A \leq 254$ is investigated. The energies of the first and second $K\pi = 2^+$ and 0^+ states, calculated taking into account the blocking effect in the framework of the approximate second quantization, agree with the corresponding experimental data. The structure of the excited states is investigated and it is found that in most cases the lowest lying $K\pi = 2^+$ and 0^+ states possess clear collective properties. In some cases the energies of quadrupole excited states lie near the secular equation poles and the structure of $K\pi = 2^+$ states is similar to the two-quasi-particle one. The particularities of the $K\pi = 0^+$ states are investigated. The spectroscopic factors are calculated for direct nuclear reactions and the relative probabilities are found for beta transitions to the $K\pi = 0^+$ states. Agreement is obtained between theory and experiment. The role of the F and Q forbiddennesses in the superfluid nuclear model is investigated. (auth)

8398 (JINR-P-1840) O VLIYANII YADERNOGO VZAIMODEISTVIYA NEITRONOV NA PARAMAGNITNYI REZONANS. (On the Influence of Nuclear Interaction of Neutrons on the Paramagnetic Resonance). V. G. Baryshevskii, V. L. Lyuboshits, and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 6p. Dep.(mn).

The influence of the neutron interaction with nuclei on the paramagnetic resonance is treated. The transition to the photon limit is investigated. (auth)

8399 (NP-14543) ÉTUDE DU SECOND TERME DE LA SÉRIE DE BORN POUR LES RÉACTIONS DE STRIPPING APPLICATION A LA RÉACTION $^{28}Si(d,p)^{29}Si$ (THÈSE). (Study of the Second Term of the Born Series for Shipping Reactions. Application to the Reaction $^{28}Si(d,p)^{29}Si$ (thesis). Jacques Pigeon (Lyon. Université). 1964. 103p. Dep.(mn).

Analytic expressions are found for the second term of the Born approximation expansion, assuming incident waves to be plane, for the reaction $^{28}Si(d,p)^{29}Si$. The order of magnitude of this second term, as well as its effect on the angular distributions, is also determined. Expressions are assumed for the interaction potentials. (T.F.H.)

8400 (NP-14574) DETERMINATION OF NUCLEAR TRANSITION PROBABILITES BY COULOMB EXCITATION. Bent Elbek (Copenhagen. Universitet. Institut for Teoretisk Fysik). 1963. 81p. Dep.(mn).

The heavy-ion Coulomb excitation is a powerful technique available for the study of collective states of nuclei. A technique that has proven useful for the assignment of multipolarities and angular momenta is the measurement of the angular distribution of gamma rays in coincidence with back-scattered particles. When larger electrostatic generators come into operation, heavy ion beams in the energy region used for this work will be available. The generators will provide an unmodulated beam, which will greatly facilitate the coincidence measurements. (auth)

8401 (TID-21338) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MÖSSBAUER STUDIES. (Johns Hopkins Univ., Baltimore). Oct. 1964. Contract AT(30-1)-2028. 255p. Dep.(mn); $6.00(cy), 5(mn) OTS.

Ten papers are included; separate abstracts have been prepared for 8. Two papers were previously abstracted in NSA, as 18: 9418 and 18: 34909. (T.F.H.)

For abstracts of individual papers see: 7773, 7789, 7790, 8009, 8141, 8402, 8403, and 8404.

8402 (TID-21338(p.53-131)) NUCLEAR POLARIZATION IN THE $B^{11}(d,p)B^{12}$ REACTION. J. J. Berlijn, P. W. Keaton, and L. Madansky (Johns Hopkins Univ., Baltimore).

Measurements are reported on the nuclear polarization of the β^--active ^{12}B recoil nucleus resulting from the $^{11}B(d,p)^{12}B$ reaction. Reaction energies of 1.1, 2.4, and 2.8 Mev were used. The recoil nuclides were stopped on Pilot B, polyethylene, copper, and solid xenon foils. The asymmetry in the β^- decay of ^{12}B was observed at mean angles of $\theta = \pm 53°$ with respect to the beam direction, which corresponds to the stripping peak for $E_d = 2.8$ Mev. At 1.1 Mev an observation at a mean angle of $\theta = +45°$ (which corresponds to the stripping peak at $E_d = 1.1$ Mev) was also made, using a polyethylene stopping foil. No significant asymmetry was observed for the Pilot B, polyethylene, or copper foils. For the solid xenon foil at a reaction energy of 2.4 Mev an asymmetry of $-4.1 \pm 0.8\%$ was observed. A xenon foil experiment at a reaction energy of 1.1 Mev did not indicate a consistent asymmetry pattern. The xenon foil experiment at a reaction energy of 2.8 Mev gave a comparatively large zero-point measurement, which would lead to an asymmetry of $-1.6 \pm 0.5\%$. (auth)

8403 (TID-21338(p.132-45)) THE $F^{19}(d,n)Ne^{20}$ ANGULAR DISTRIBUTION. S. I. Warshaw (Johns Hopkins Univ., Baltimore).

Measurements are made of the neutron distributions (especially for angles greater than 150°) from (d,n) reactions with ^{10}B and ^{19}F, at deuteron energies of 1 to 3 Mev. The contributions from the reactions proceeding to the ground, first, and possibly second and third excited states of the residual nuclei are considered separately. (T.F.H.)

8404 (TID-21338(p.182-9)) MÖSSBAUER-EFFECT STUDIES. J. C. Walker (Johns Hopkins Univ., Baltimore).

A description is given of velocity drive systems used to obtain triangular velocity waveforms for Mössbauer studies. Some experimental results obtained with this apparatus are outlined. (T.F.H.)

8405 (UCRL-7155(Rev.I)) ZERO-ENERGY PARAMETERS FOR ATTRACTIVE AND REPULSIVE GAUSSIAN, EXPONENTIAL, YUKAWA, AND HARD-CORE YUKAWA POTENTIALS. Richard D. Levee and Robert L. Pexton (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 7, 1963. Contract W-7405-eng-48. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Solutions to the radial wave equation at zero energy have been obtained for Gaussian, exponential, and Yukawa potentials for values of the strength parameters lying between -4 and $+2$ and for hard-core Yukawa potentials for values of s lying between 0 and $+2$. Tables of the scattering length a and the effective range r_0 as determined from these solutions for these values of s are given. Remarks are made concerning a formula for a shape-independent s. (auth)

8406 (UNC-5090) A LISTING OF CINDA. An Index to the Literature on Microscopic Neutron Data. Herbert Goldstein (Columbia Univ., New York) and Malvin H. Kalos (New York Univ., New York. Courant Inst. of Mathematical Sciences and United Nuclear Corp. [Development Div., White Plains, N. Y.]). July 1, 1964. 792p. (AD-607668; DASA-1535; NDL-SP-10; EANDC(US)-69L). $10.90(OTS).

A bibliographical tabulation of information on microscopic neutron cross sections and allied data for specific elements, isotopes, and materials is presented. The tabulation covers the years since the beginning of 1956. (T.F.H.)

8407 (NP-14468) THE NON-ADDITIVE COULOMB CONTRIBUTION TO THE ELASTIC SCATTERING AMPLITUDE AT HIGH ENERGIES. N. N. Achasov and V. F. Pleshakov (Akademiya Nauk S.S.S.R. Institut Matematiki, Novosibirsk). Translated by N. Chernova. 1964. 12p. Dep.(mn).

The nonadditive coulomb contribution to the elastic scattering amplitude of charged particles at high energies is investigated. This contribution is calculated for s and p partial waves and also for the total amplitude. The main result is that at high energies and small angles of scattering the total amplitude comprises a nonadditive contribution from the interference of nuclear and coulomb interactions. The order of the magnitude of this contribution to the differential cross section may be compared to the contribution derived by the additive summing up of both amplitudes. (auth)

8408 ON THE MONOENERGETIC POSITION LINE IN THE DECAY OF Eu^{152}. Harry Pettersson and Sven Antman (Uppsala Univ.). Arkiv Fysik, 28: 93-6(1964).

A search for the monoenergetic positron emission which follows the decay of the 1408.03 ± 0.12 kev transition in ^{152}Cm was performed using a 50 cm radius double focusing iron yoke spectrometer. An upper limit of 2×10^{-7} for the ratio $N^{K}_{e^+}/N\gamma$ was obtained giving a mean life for the initial 1530-kev level of greater than 7×10^{-15} sec. (auth)

8409 CALCULATIONS OF NEUTRON CROSS SECTIONS FOR ^{238}U AND ^{232}Th. G. I. Marchuk, V. E. Kolesov, and A. G. Dovbenko. At. Energ. (USSR), 17: 304-7(Oct. 1964). (In Russian)

A previously developed computer program was used to calculate the total cross sections, the cross sections for compound-nucleus formation, and the transport cross sections of neutrons from 0.01 to 10 Mev in ^{238}U and ^{232}Th. Excitation functions for the first two excited states with neutron inelastic scattering by ^{238}U and ^{232}Th and radiative capture cross sections by the same nuclei were also computed. All the results are presented graphically and compared with previous experimental values. (M.J.T.)

8410 SYNTHESIS AND PHYSICAL IDENTIFICATION OF ELEMENT 104 WITH THE MASS NUMBER OF 260. G. N. Flerov, Yu. Ts. Oganesyan, Yu. V. Lobanov, V. I. Kuznetsov, V. A. Druin, V. P. Perelygin, K. A. Gabrulov, C. P. Tret'yakova, and B. M. Plotko. At. Energ. (USSR), 17: 310-12(Oct. 1964). (In Russian)

The reaction ^{242}Pu (^{22}Ne, 4n) ^{260}104 was considered. Enriched Pu targets were bombarded with Ne ions at 113 to 115 Mev in the internal beam of a cyclotron. The formation of a spontaneously fissioning isotope with half life of about 0.3 sec and cross section of about 2×10^{-34} cm^2 was observed. The possibility that this isotope was not ^{260}104 was eliminated through experiments in bombarding ^{238}U with ^{22}Ne and ^{242}Pu with ^{20}Ne and ^{18}O; nearly all possible spontaneously fissioning isotopes can be formed in these experiments, except ^{260}104. No 0.3-sec isotope was observed, and it was concluded that ^{260}104 was produced in the initial experiment. (M.J.T.)

8411 CHANNEL EFFECTS IN FISSION OF COMPLEX EVEN-EVEN NUCLEI. L. N. Usachev, V. A. Pavlinchuk, and N. S. Rabotinov. At. Energ. (USSR), 17: 479-85(Dec. 1964). (In Russian)

An analysis was made of experimental data on the fission of even-even complex nuclei in (d,pf), (γ,f), and (n,f) reactions near a threshold. The fission widths were estimated using the Bohr and Wheeler formula. The obtained data are in good agreement with Bohr fission-channel structure. It was also found that fission channels with negative parity are located 0.6 to 0.8 Mev above the first positive-parity channels. The Bohr-Wheeler formulas describe the quantitative mean fission width of the (n,f) reaction resonances in ^{233}U, ^{235}U, and ^{241}Pu. Strong deviations of the data for ^{239}Pu are explained by negative parity in the ground state. (tr-auth)

8412 CROSS SECTIONS FOR RADIATIVE CAPTURE OF FAST NEUTRONS BY IRON. A. V. Malyshev, Yu. Ya. Stavisskii, and A. V. Shapar. At. Energ. (USSR), 17: 508-9 (Dec. 1964). (In Russian)

The influence of high energy neutrons on the behavior of radiative capture cross sections was studied by measuring σ_γ for natural iron at neutron energies of 1, 1.2, and 1.4 Mev. The energy resolution was 40 kev, and the order of accuracy 20%. The curves of energy dependence in radiative capture cross sections showed that at energies exceeding 900 kev the cross section diminished; at energies of 1.2 to 1.4 Mev the cross section diminished to ~ 2 mb. It was also found that strong excitation of the 845-kev ($J = 2^+$) level resulted in considerable diminishing of the cross section in ^{56}Fe. Calculations of radiative capture cross sections for ^{54}Fe and ^{57}Fe at 1345 kev indicated 7.8 mb and 4.9 mb, respectively, and 1.9 mb for the natural isotopic mixture, in good agreement with the measurements. (R.V.J.)

8413 HEAVY ISOTOPES OF THE LIGHTEST ELEMENTS. B. M. Spicer (Univ. of Virginia, Charlottesville). At. Energy Australia, 7: No. 4, 31-3(Oct. 1964).

It is noted that knowledge of the nature of the two-nucleon force is of great importance in nuclear physics. Discussion is presented to show that ^{8}He offers the best hope of using the properties of heavy isotopes of the lightest nuclei in nucleon-nucleon force studies. (J.R.D.)

8414 A NEW GAMMA TRANSITION FOLLOWING THE DECAY OF 2.4-MINUTE ^{108}Ag. H. W. Taylor (Univ. of Alberta, Edmonton, Can.) and T. A. Eastwood. Can. J. Phys., 42: 2173-9(Nov. 1964). (AECL-2097)

A low-intensity peak was found at 1010 ± 30 kev in the gamma spectrum of 2.4-minute ^{108}Ag obtained with NaI scintillation spectrometers. Consideration of the source-to-crystal distance as well as the effects of absorbers and decay time shows that it is the full-energy peak of a 1010 ± 30 kev gamma ray emitted by ^{108}Ag. Gamma-gamma coincidence studies indicate that this gamma transition occurs between a new level at 1433 ± 30 and the 433-kev level of ^{108}Pd. (auth)

8415 HIGH-RESOLUTION STUDIES OF GAMMA-RAY SPECTRA USING LITHIUM-DRIFT GERMANIUM GAMMA-RAY SPECTROMETERS. G. T. Ewan and A. J. Tavendale (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 2286-2331(Nov. 1964). (AECL-2079)

The use of germanium lithium-drift p-i-n diodes as high-resolution γ-ray spectrometers is described. With these spectrometers γ-ray resolutions of 2.05 kev at 122 kev, 4.0 kev at 1333 kev, and 5.5 kev at 2614 kev were obtained. Using the detectors as pair spectrometers for high-energy γ rays, a resolution of 9.8 kev on a 7.6-Mev γ ray was obtained. The factors affecting the resolution of the detectors are discussed. Fano factors of ~0.4 were observed. Efficiency curves are given for a 2.5 cm^2 × 3.5 mm detector and for a 5 cm^2 × 8 mm detector. The detectors were used to make high-resolution studies of the complex γ spectra from sources of ^{134}Cs, ^{151}Pm, ^{152}Gd, ^{156}Eu, ^{159}Gd, ^{177}Yb, and ^{226}Ra. Results are reported for the energies and intensities of the γ rays observed in these studies. (auth)

8416 THE TOTAL NEUTRON CROSS SECTION OF ^{241}Pu BELOW 1000 ev. D. S. Craig and C. H. Westcott (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 2384-94(Dec. 1964). (AECL-2084)

Measurements were made of the total neutron cross section of ^{241}Pu over the energy ranges of 0.025 to 0.75 ev and 13.8 to 1000 ev, using a specimen of PuO_2 powder and one of Pu–Al alloy. The ^{241}Pu content of the plutonium was 80%. The specimen thickness was known to 2%. The measurements were made with the B.N.L.-A.E.C.L. chopper at C.R.N.L., using resolutions up to 0.02 μsec/m. The results are given in graphical form. Resonance parameters are given for the region from 12 to 32 ev. When these parameters are used with the single-level Breit-Wigner formula a reasonable fit to the data is obtained. (auth)

8417 ANGULAR DISTRIBUTIONS IN THE ^{27}Al(p,γ_0)^{28}Si REACTION. J. B. Seaborn and J. M. Eisenberg (Univ. of Virginia, Charlottesville). Can. J. Phys., 42: 2497-9(Dec. 1964).

Particle-hole wave functions were used to calculate the angular distributions from the ^{27}Al(p,γ)^{28}Si reaction. The incident radiation was considered to be unpolarized, and only those channels that leave ^{27}Al in its $5/2^+$ ground state are included. The calculations are compared with previous experimental results, and it is found that in the particle-hole model the f-wave contributions are apparently too large to account for the lack of energy dependence exhibited by the gamma angular distributions. (C.E.S.)

8418 γ-RAY SPECTRUM OF Sb^{131}. J. A. Cooper, R. C. Gatti, J. O. Rasmussen, and S. G. Thompson (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 26: 2041-4(Dec. 1964). (UCRL-11255)

The γ spectrum of 25.5 ± 2 min ^{131}Sb was investigated with a scintillation spectrometer. Gamma rays with ener-

gies of 0.645 and 0.950 Mev were observed, and their absolute abundances determined. (auth)

8419 SCATTERING OF ALPHA PARTICLES ON ^{12}C(E_α = 18 to 24 Mev). J. C. Jodogne and P. C. Macq (Université, Louvain, Belg.). J. Phys. (Paris), 25: 803-4 (Aug.-Sept. 1964). (In French)

The effective differential cross section for alpha scattering to the ground and first-excited states of ^{12}C was measured at a laboratory angle of 174° for alpha energies between 17.3 and 23.4 Mev. The angular distributions for scattering to the three lowest levels were measured at alpha energies of 20.3 ± 0.5 and 21.9 ± 0.5 Mev, corresponding, respectively, to the minimum and the maximum of the cross section. (D.C.W.)

8420 STUDY OF THE EFFECTS OF THE HYPERFINE STRUCTURE OF EXCITED LEVELS ON OBTAINING A NUCLEAR ORIENTATION BY OPTICAL PUMPING. Jean-Claude Lehmann (Ecole Normale Supérieure, Paris). J. Phys. (Paris), 25: 809-24(Aug.-Sept. 1964). (In French)

Nuclear orientation by optical pumping is studied under more general conditions than were previously considered. The effect of the magnitude of the hfs of the excited level in relation to its natural width is considered, as well as the effects of the partial decoupling of this hfs by the magnetic field. Density matrix formalism is used. The case of $I = 1/2$, corresponding to ^{111}Cd and ^{113}Cd, is treated in detail. (D.C.W.)

8421 SPECTROSCOPIC DETERMINATION OF THE QUADRUPOLE MOMENT OF THE NUCLEUS OF ^{241}Pu. René-Jean Champeau (CNRS, Bellevue, France). J. Phys. (Paris), 25: 825-30 (Aug.-Sept. 1964). (In French)

The quadrupole coupling factor B of the $5f^6\ 7s\ ^8F_{\frac{1}{2}}$ level of Pu II was derived from hfs measurements of three spark lines of ^{241}Pu, emitted by an electrodeless discharge tube and recorded with a Fabry-Perot spectrometer. The nuclear quadrupole moment was determined from the B value using the wave function of the $^8F_{\frac{1}{2}}$ level in intermediate coupling. A value of $Q = +(5.6 \pm 2)\ 10^{-24}\ cm^2$ was obtained, in good agreement with the theoretical predictions of Mottelson and Nilsson. (auth)

8422 SHAPE OF NUCLEAR MAGNETIC RESONANCE SIGNALS IN SOLIDS. M. Goldman (Centre d'Études Nucléaires, Saclay, France). J. Phys. (Paris), 25: 843-52 (Aug.-Sept. 1964). (In French)

The theory of Provotorov is used to study the shape of the NMR signals recorded after lock-in detection and the saturation effect of the field modulation. The analysis is developed under restrictive conditions which simplify the calculations, but correspond nevertheless to practical experimental procedures. The results permit the selection of suitable conditions for obtaining accurate results on the shape of the absorption line and the spin-lattice relaxation times. (auth)

8423 RESULTS OF ANALYSIS OF FISSION CROSS SECTION CURVES OF URANIUM-233. H. Nifenecker (Centre d'Etudes Nucléaires, Saclay, France). J. Phys. (Paris), 25: 877-82(Oct. 1964). (In French)

The results are given of a preliminary analysis of the previously obtained fission cross section of ^{233}U. This analysis intended first to give approximate parameters of the resonances to be used as preliminary estimates in a shape analysis of the data, and second, to allow a statistical study of the resonances. (auth)

8424 VALUE OF Bρ OF SOME SPECTRAL LINES OF Th(B + C + C″). J. L. Wininger (Université de Paris, Orsay, France). J. Phys. (Paris), 25: 897-8(Oct. 1964). (In French)

By means of a very carefully calibrated β spectrometer, the Bρ values of the G, G_a, H, J_a, J_b, and J_c lines of radiothorium are given with an accuracy of 0.03%. (auth)

8425 EXCITED LEVELS OF ^{58}Co BY THE REACTION $^{58}Fe(p,n)^{58}Co$. M. Croissiaux, E. Dally, H. Distelzwey, and Gehringer (Institut de Recherches Nucléaires, Strasbourg). J. Phys. (Paris), 25: 906-8(Oct. 1964). (In French)

Excited states of ^{58}Co were studied by the reaction $^{58}Fe(p,n)^{58}Co$, for comparison with a simple theory of medium nuclei. Two excited states at 1.055 ± 0.015 and 1.395 ± 0.015 Mev above the ground state were found. (auth)

8426 ENERGY DEPENDENCE OF THE D-D REACTION CROSS SECTION AT LOW ENERGIES. J. G. Brennan (Catholic Univ. of America, Washington, D. C.) and J. J. Coyne. J. Res. Natl. Bur. Std., 68A: 675-82 (Nov.-Dec. 1964).

The energy variation of the approach cross section for the D-D reaction is calculated using several different methods. The simplest method assumes strong absorption inside the nuclear surface and uses the WKB approximation. The slope of the Gamow plot is in this case a constant. A strong absorption model, without WKB approximation, leads to negative corrections to this constant slope. A weak absorption model, which seems more applicable, gives both positive and negative corrections, depending on the depth of the nuclear potential. Finally, since the amount of absorption seems important, the effects of varying the absorption are studied using the optical model. The possible influence of the P-waves is also investigated. An experimental study of the energy dependence of the slope of the Gamow plot should give information on the optical potential which one deuteron sees when it approaches another deuteron. (auth)

8427 RADIOACTIVE EQUILIBRIA. D. Nachtigall. Kerntechnik, 6: 470-4(Oct. 1964). (In German)

Radioactivity at various stages in a decay series is discussed. Continuous and permanent radioactive equilibrium is treated. Larger half lives in daughter substances and decay rate of a radioactive decay series are considered. Equations are presented for calculations of equilibrium. (M.C.G.)

8428 SHELL-MODEL SEMI-EMPIRICAL NUCLEAR MASSES. [PART] I. N. Zeldes, M. Gronau, and A. Lev (Hebrew Univ., Jerusalem). Nucl. Phys., 63: 1-74(Mar. 1965).

The 1961 Nucleidic Mass Table was revised by a least-squares adjustment including newer experimental data. Differences of nuclear masses were plotted as functions of N and Z, revealing shell and other structure effects. The information obtained from these graphs was used to construct a generalized shell model mass formula, representing the experimental masses of not too light nuclei with an accuracy of about 200 kev. (auth)

8429 A NEW NUCLIDE EUROPIUM 143. K. Kotajima, K. W. Brockman, Jr., and Gerda Wolzak (Instituut voor Kernphysich Onderzoek, Amsterdam). Nucl. Phys., 63: 75-8(Mar. 1965).

A new nuclide europium-143, produced by the (d,3n) reaction on ^{144}Sm, was investigated. The half life of this nucleide was found to be $T_{\frac{1}{2}} = 2.3 \pm 0.2$ min and the end-point energy of the beta ray was found to be $E_\beta = 4.0 \pm 0.2$ Mev. No strong gamma ray was observed. (auth)

8430 RELATIVE INTENSITIES OF GAMMA RAYS FOLLOWING THE DECAY OF Ta^{182} AND Ta^{183}. W. F. Edwards, F. Boehm, J. Rogers, and E. J. Seppi (California Inst. of Tech., Pasadena). Nucl. Phys., 63: 97-101(Mar. 1965).

The relative intensities of gamma transitions in the ^{182}W and ^{183}W nuclei were measured with an accuracy of 5% using a bent-crystal gamma spectrometer. A careful analysis of the various corrections applied was made. With only minor exceptions the results are in good agreement with other experimental results substantiating the technique for measuring precisely gamma ray intensities with a bent-crystal spectrometer. The gamma ray branching ratios in ^{183}W obtained serve as a basis for a band mixing analysis. (auth)

8431 CORIOLIS COUPLING BETWEEN ROTATIONAL BANDS IN THE NUCLEUS W^{183}. R. T. Brock-

meier, S. Wahlborn, E. J. Seppi, and F. Boehm (California Inst. of Tech., Pasadena). Nucl. Phys., 63: 102-30(Mar. 1965).

The experimental data of the K = 1/2 and 3/2 bands of the nucleus ^{183}W were analyzed by performing least-squares fits to energy levels and gamma-ray intensities within the model RPC (rotational and particle motion with Coriolis band-mixing). If in addition to the two close-lying levels 3/2⁻[512] and 1/2⁻[510] seven other levels predicted by the Nilsson model are included, significant improvement in the energy fit is obtained. In the intensity fit, all free electric and magnetic parameters of the two close-lying levels are varied. As one result, the moments of inertia and the intrinsic quadrupole moments consistently indicate a somewhat greater deformation in the K = 3/2 band. The result of the fit is compared with the predictions of the Nilsson model, with suitably adjusted potential parameters; in particular the experimental value of the decoupling constant is accounted for. Magnetic moments were calculated; for the ground state, the value derived from the intensity fit shows fair agreement with experiment. (auth)

8432 THE β-DECAY OF I^{130} AND ξ-APPROXIMATION. H. Daniel, M. Kuntze, B. Martin, P. Schmidlin, and H. Schmitt (Max-Planck-Institut für Kernphysik, Heidelberg). Nucl. Phys., 63: 145-60(Mar. 1965). (In German)

The β decay $^{130}I \rightarrow {}^{130}Xe$ was thoroughly investigated. The β and e^- spectra were measured with a double lens spectrometer, the γ spectrum with a scintillation spectrometer, four $\beta-\gamma$ directional correlations with a scintillation counter set-up, and two β-(circularly polarized γ) correlations via the method of Compton forward scattering. The β spectrum consists of three groups: 1.78 Mev (0.4%), 1.04 Mev (48%), and 0.62 Mev (52%). The γ spectrum shows five lines: 0.419 Mev (36% transition intensity per decay; 0.5% E2 + 99.5% M1), 0.538 Mev (100%; E2), 0.669 Mev (100%; E2), 0.743 Mev (87%; 89% E2 + 11% M1), and 1.15 Mev (12%; E2). The ^{130}Xe level spectrum consists of the ground state (0^+) and excited states of 0.54 Mev (2^+), 1.21 Mev (4^+), 1.95 Mev (5^+), and 2.37 Mev (6^+). The ground state of ^{130}I is 5^-. The three β transitions populate the three upper levels and, hence, are non-unique first forbidden. The two strong groups show allowed shape and very small though non-vanishing energy-independent reduced anisotropy coefficients ϵ' while the weak group has an isotropic correlation with the succeeding γ radiation. Therefore, the β-(circularly polarized γ) correlations are interpreted in terms of the ξ approximation which is reviewed. It is concluded that the β decay of ^{130}I is a good example for the validity of the ξ approximation. (auth)

8433 ERICSON'S FLUCTUATIONS IN THE PHOTODISINTEGRATION OF Si^{28}. P. G. Bizzeti, A. M. Bizzeti Sona, M. Bocciolini, G. di Caporiacco, T. Fazzini, and M. Mando (Università, Florence and INFN, Florence). Nucl. Phys., 63: 161-72(Mar. 1965).

The cross section of the reactions $^{28}Si(\gamma,p)^{27}Al$ and $^{28}Si(\gamma,\alpha)^{24}Mg$ were measured in an energy range ΔE = 117 kev around 17.62 Mev gamma ray energy. Six different transitions (γ,p_0), (γ,p_1), (γ,p_2), (γ,p_4), (γ,α_0) and (γ,α_1) were separately analyzed; they show strong, uncorrelated fluctuations, the amplitude of which agrees with Ericson's predictions (pure statistical reaction and purely El gamma absorption being assumed). Some contribution of direct effect is not excluded. The relative yield of (γ,α) to (γ,p) transitions is, on the average, lower than the statistical model would predict, on the basis of transmission coefficients. This is interpreted as an example of the isobaric spin selection rules, as applied to photodisintegration by Gell-Mann and Telegdi. (auth)

8434 ELASTIC AND INELASTIC SCATTERING OF ELECTRONS ON COMPLEX NUCLEI. G. Ciocchetti and A. Molinari (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (1), 2: Suppl., 59-145(1964). (In Italian)

The scattering of high-energy electrons on atomic nuclei is reviewed. The Born approximation, elastic scattering, and discrete and continuous inelastic scattering are considered. (J.S.R.)

8435 EMISSION OF FAST HELIUM NUCLEI AND TRITONS FROM HIGH-ENERGY NUCLEAR DISINTEGRATIONS. M. Yasin (Aligarh Muslim Univ., India). Nuovo Cimento (10), 34: 1145-51(Dec. 1, 1964).

On the basis of the result that from high-energy nuclear disintegration fast helium nuclei and tritons with energies greater than 50 Mev are emitted with equal frequencies, various known mechanisms for the emission of these particles are examined. It is suggested that such emission can take place through the absorption of mesons in ^{4}He clusters present in the outer region of the nucleus. (auth)

8436 ON THE REAL PART OF THE SCATTERING AMPLITUDE OF PROTON-NUCLEUS INTERACTIONS AT 12 Gev/c AND 24 Gev/c. D. J. Holthuizen (Universiteit, Amsterdam). Nuovo Cimento (10), 34: 1413-30(Dec. 16, 1964).

Measurements were made of the elastic and inelastic interactions of protons of 12 and 24 Bev/c in nuclear emulsion. For this purpose, 500 m tracks of 12 Bev/c and 650 m tracks of 24 Bev/c protons were followed under the microscope. Special recorders were connected to these microscopes in order to show small deflections in the tracks with a large angle magnification. The aim was to investigate the presence of interference between the Coulomb scattering amplitude and the real part of the nuclear scattering amplitude. Three models were used to analyze the experimental results. In all cases an interference term is necessary to obtain a satisfactory fit of the experimental results. The interference between the Coulomb scattering amplitude and the real part of the nuclear scattering amplitude is constructive. (auth)

8437 THE ABSORPTION OF NEGATIVE PIONS BY COMPLEX NUCLEI (COPPER, TIN AND LEAD). G. Campos Venuti, G. Fronterotta, and G. Matthiae (Istituto Superiore di Sanità, Rome and Istituto Nazionale di Fisica Nucleare "Sottosezione Sanità", Rome). Nuovo Cimento (10), 34: 1446-57(Dec. 16, 1964).

An experiment performed at the electron synchrotron is described for measuring the energy spectrum of neutrons emitted in the energy range from about 1 to 50 Mev in the capture of negative pions at rest in complex nuclei. The experimental data obtained using targets of Cu, Sn, and Pb are presented and discussed. Each of the energy spectra of neutrons emitted is characterized by a low-energy evaporation part with a maximum at about (2 – 3) Mev. Comparison of data obtained in π^- absorption in the almost double magic nucleus of Pb, with results of other experiments using the same excitation energies, shows shell-model effects on evaporation processes. (auth)

8438 RELATION BETWEEN PARASITIC SCATTERING AND DISTORTION IN PHOTOGRAPHIC NUCLEAR EMULSIONS. P. Heinzer (Laboratoire de Recherches Nucléaires E.P.U.L., Lausanne, Switzerland). Nuovo Cimento (10), 34: 1756-73(Dec. 16, 1964). (In French)

A study of a possible relation between spurious scattering as measured on flat and dipping tracks on one hand, and distortion and its fluctuations as measured on vertical tracks on the other hand is presented. (auth)

8439 THE ELASTIC SCATTERING OF PROTONS BY ^{6}Li IN THE ENERGY RANGE (1.3 ÷ 5.6) Mev. U. Fasoli, E. A. Silverstein, D. Toniolo, and G. Zago (Università, Padua). Nuovo Cimento (10), 34: 1832-6(Dec. 16, 1964).

The elastic scattering of protons by ^{6}Li at 1.3 to 5.6 Mev was investigated to study the ^{6}Be nuclide in the excitation energy region above 7.18 Mev up to 10 Mev. A resonance at about 9.9 Mev excitation energy with Γ = 1.5 Mev was observed. Excitation curves and angular distributions are illustrated. (C.E.S.)

8440 STATISTICAL FLUCTUATIONS AND INTERMEDIATE STRUCTURES IN NUCLEAR REACTION CROSS

SECTIONS. G. Pappalardo (Università, Catania, Italy). Phys. Letters, 13: 320-2(Dec. 15, 1964).

The possibility of discriminating between structures and statistical fluctuations occurring in the same excitation function is analyzed. A method is proposed for the case in which the width of the compound nucleus levels is expected to be much smaller than the intermediate resonances width. The reaction $^{58}Ni(p,p)^{58}Ni$ is considered. (C.E.S.)

8441 EFFECTS OF NUCLEAR STRUCTURE ON THE SCATTERING ON POLARIZED PROTONS. E. T. Boschitz, R. W. Bercaw, and J. S. Vincent (Lewis Research Center, Cleveland). Phys. Letters, 13: 322-4(Dec. 15, 1964).

It was previously found that the polarization of protons in elastic scattering varies rapidly at large angles as a function of mass number, and it was suggested that the spin-orbit potential may depend on the closing of shells or have an isospin dependence as does the central potential. An experiment designed to explore any such structural effect on the polarization for the $^{40}Ar-^{40}Ca$ pair and to extend previous measurements on other nuclei to the 16 to 21 Mev range is discussed. The nuclei ^{39}K, ^{58}Ni, ^{59}Co, ^{116}Sn, and ^{122}Sn were investigated. It was suggested that the sensitivity of the polarization to structure has a dependence on proton energy that seems to be understandable on the basis of potential scattering. (C.E.S.)

8442 ON THE COUPLING BETWEEN THE DIPOLE AND QUADRUPOLE VIBRATIONS IN SPHERICAL NUCLEI. J. Le Tourneux (Univ. of Virginia, Charlottesville). Phys. Letters, 13: 325-8(Dec. 15, 1964).

The effect of the dipole-quadrupole interaction on the structure of the giant dipole line in spherical nuclei is discussed. The structure of the giant dipole resonance for elastic and inelastic scattering of γ rays is investigated. Numerical calculations were performed for ^{76}Se. (C.E.S.)

8443 SELECTION RULES FOR TWO NUCLEON STRIPPING REACTIONS. A. Y. Abul-Magd and M. El-Nadi (Atomic Energy Establishment, Cairo). Phys. Letters, 13: 328-30(Dec. 15, 1964).

The transition amplitude for ^3He and triton projectiles in the distorted-wave theory of two-nucleon stripping reactions is discussed. Selection rules were derived for the case in which the captured nucleons are identical and for the case in which the nucleons are a neutron and a proton. The selection rules can also be applied to (α,d) and similar reactions. (C.E.S.)

8444 MEASUREMENT OF THE g-FACTOR OF THE 90 kev STATE OF Ru^{99} BY THE SPIN ROTATION METHOD. E. Bodenstedt, C. Guenther, J. Radeloff, W. Engels, W. Delang, M. Forker, and H. Luig (Universität, Bonn). Phys. Letters, 13: 330-2(Dec. 15, 1964).

The 90-kev state of ^{99}Ru was investigated. The lifetime of this state was determined to be 19.7 ± 0.4 nsec. A differential measurement of the 349-90 kev angular correlation was performed to investigate the perturbation by internal fields. The perturbation was very weak, and the integral attenuation was found to be 0.93 ± 0.06. The coefficients of the 525-90 kev angular correlation were also determined. The measurement of the spin rotation was performed in an external magnetic field of 31,000 gauss. The Larmor precession frequency and the g-factor were derived to be $\omega_L = (3.87 \pm 0.11) \times 10^7$ sec^{-1} and g = +0.261 ± 0.008. (C.E.S.)

8445 CROSS SECTION FLUCTUATIONS IN ISOSPIN FORBIDDEN REACTIONS. P. G. Bizzeti (Università, Florence). Phys. Letters, 13: 334-5(Dec. 15, 1964).

It is shown that for isospin forbidden transitions one may expect not only a smaller cross section but also an anomalous behavior of the fluctuations with respect to the prediction of the normal Ericson's theory. The calculations are limited to the case of purely statistical reactions, which certainly includes the forbidden ones. The presence of a direct contribution in the competing allowed transitions should not alter the results for the forbidden ones. (C.E.S.)

8446 ON π^--NUCLEON INTERACTIONS IN XENON NUCLEI. Z. S. Strugalski and T. Siemiarczuk (Inst. of Nuclear Research, Warsaw). Phys. Letters, 13: 347-9 (Dec. 15, 1964).

Interactions of mesons (π^-) of 9-Bev/c momentum were investigated in a xenon bubble chamber. The analysis of the results suggests that when the number of charged secondary particles is small, an important role is played by such meson (π^-)-nucleon interactions in xenon nuclei that are not followed by secondary nuclear processes. (C.E.S.)

8447 NEW MEASUREMENTS OF β-CIRCULARLY-POLARIZED γ ANGULAR-CORRELATION ASYMMETRY PARAMETERS IN ALLOWED β DECAY. L. G. Mann, D. C. Camp, J. A. Miskel, and R. J. Nagle (Univ. of California, Livermore). Phys. Rev., 137: B1-12(Jan. 11, 1965). (UCRL-7699)

The angular-correlation asymmetry parameter for circularly polarized γ rays following allowed β decay was measured for several nuclides. The polarimeter employed the usual forward Compton scattering of γ rays, but the magnetic field direction was reversed every 7 msec (70 cps). Beta, gamma, and coincidence rates with the magnetic field off, and the single-detector β and γ rates during all measurements (field on), show that spurious instrumental effects are an order of magnitude smaller than the statistical errors in these measurements. Details of the calibration procedure, which utilized ^{60}Co and was checked with ^{22}Na and ^{56}Mn, and of the corrections for several spurious effects are given. The measured asymmetry parameters A, and the isotopic-spin impurity coefficients α, which can account for the Fermi component in the mixed β decays, are given for ^{44}Sc, ^{46}Sc, ^{47}Cu, ^{48}Sc, ^{52}Mn, ^{58}Co, ^{59}Fe(273 kev β), ^{59}Fe(475 kev β), and ^{124}Sb. The existing circular-polarization data are compared with the recent calculations of the Fermi matrix element by Blin-Stoyle and Novakovic, for ^{24}Na, ^{41}Ar, ^{44}Sc, and ^{52}Mn. (auth)

8448 LEVELS OF Nd^{146} FROM THE DECAY OF Pr^{146}. A. V. Ramayya and Y. Yoshizawa (Indiana Univ., Bloomington). Phys. Rev., 137: B13-16(Jan. 11, 1965).

A 24-min radioisotope of ^{146}Pr was produced by the $^{146}Nd(n,p)^{146}Pr$ reaction. Beta and gamma rays of ^{146}Pr were investigated with scintillation spectrometers and coincidence techniques. Analysis of the singles and coincidence spectra indicate gamma rays of energies 0.11, 0.455, 0.59, 0.74, 0.78, 0.92, 1.02, 1.16, 1.26, 1.34, 1.37, 1.51, 1.66, 1.72, 1.96, 2.23, 2.39, and 2.73 Mev. From the relative intensities of the gamma rays and the beta-gamma coincidence spectra, the branching ratios of the beta rays and the log ft values are calculated. A decay scheme consistent with the experimental data is presented. The low-lying states of ^{146}Nd are compared with those of neighboring ^{148}Sm and ^{150}Sm nuclei. (auth)

8449 N^{17} ENERGY LEVELS AND GAMMA RAYS. Vincent P. Hart, E. Norbeck, and R. R. Carlson (State Univ. of Iowa, Iowa City). Phys. Rev., 137: B17-23(Jan. 11, 1965).

The nuclear reaction $^7Li + ^{11}B$ was studied with the use of a three-parameter analysis technique. The three parameters recorded were particle type, particle energy, and energy of gamma rays in time coincidence with the charged particles. Both ungated particle spectra and particle–gamma-ray coincidence data were taken simultaneously. Particles were detected by a E-dE/dX system made up of solid-state detectors. The gamma rays were detected in a large NaI(Tl) crystal. The data gathering and analyzing system consisted of three pulse-height analyzers (256 channels for E_γ and ΔE, and 1024 channels for $E_{particle}$), and a small general-purpose computer with magnetic tape units and an oscilloscope display. The energies of protons from the reaction $^{11}B(^7Li,p)^{17}N$ were measured. Groups corresponding to previously observed states in ^{17}N were seen as well as 14 new states. Spectra of gamma rays from the bound levels of ^{17}N were analyzed to give the decay schemes and some branching ratios. Calibrations were obtained from gamma rays of known energy produced in the reaction

and from the known energies of some of the proton, deuteron, and triton groups. (auth)

8450 LIFETIMES OF THE FIRST EXCITED STATES IN Ru^{99} AND Xe^{129}. O. C. Kistner, S. Monaro, and A. Schwarzschild (Brookhaven National Lab., Upton, N. Y.) Phys. Rev., 137: B23-5(Jan. 11, 1965). (BNL-8403)

Lifetimes of the first excited states in ^{99}Ru (90 kev) and ^{129}Xe (40 kev) were measured using the delayed coincidence technique. The half lives obtained are $(20 \pm 1) \times 10^{-9}$ sec for ^{99}Ru and $(0.96 \pm 0.05) \times 10^{-9}$ sec for ^{129}Xe. These are in agreement with the lower limits previously determined by Mössbauer experiments. The E2 part of the 90-kev transition of ^{99}Ru is enhanced by a factor of ~50 relative to the Weisskopf estimate, while the M1 part is retarded by a factor between 2400 and 7400. The 40-kev M1 transition in ^{129}Xe is retarded by at least a factor of 31 relative to Weisskopf estimates. (auth)

8451 PULSED-BEAM MEASUREMENT OF THE GYROMAGNETIC RATIO OF THE 111-kev 2^+ STATE IN TUNGSTEN-184. R. P. Scharenberg, J. D. Kurfess, G. Schilling, J. W. Tippie, and P. J. Wolfe (Case Inst. of Tech., Cleveland). Phys. Rev., 137: B26-31(Jan. 11, 1965).

The gyromagnetic ratio of the 111-kev 2^+ rotational state in tungsten-184 was measured using the pulsed-beam technique. The precession of the Coulomb-excited nuclei in an external magnetic field was detected by observing the de-excitation gamma radiation as a function of time. The value $g = 0.275 \pm 0.025$ was found. The timing techniques which make possible an evaluation of the effect of target perturbations on the measurement are discussed. The mean life of the state was measured to be $\tau = (1.85 \pm 0.03) \times 10^{-9}$ sec, which is in agreement with other measurements. (auth)

8452 STUDIES ON THE $Ne^{20}(d,p\gamma)Ne^{21}$ REACTION. A. J. Howard and D. A. Bromley (Yale Univ., New Haven). Phys. Rev., 137: B32-57(Jan. 11, 1965).

The ^{21}Ne states below an excitation energy of 5 Mev were investigated through study of the ^{20}Ne(d,pγ)^{21}Ne reaction with deuteron energies in the range below 3 Mev. Precise de-excitation branching ratios were determined for the 1.75 2.80, 3.67, and 4.73 Mev ^{21}Ne states; the most prominent gamma de-excitation mode for all but one of the eleven excited states of ^{21}Ne up to an excitation energy of 4.73 Mev was established. The lowest excitation in ^{21}Ne was determined to be 353 ± 1.5 kev, and an unambiguous J^π assignment of $5/2^+$ and a mean lifetime of $<3 \times 10^{-10}$ sec were also established; the E2-to-M1 amplitude ratio for this state de-excitation was measured to be $-0.02 \leq \delta \leq +0.03$. A J^π assignment of $7/2^+$ is strongly suggested for the 1.75 Mev ^{21}Ne second excited state, and both a significant (7 ± 1%) E2 de-excitation radiation branch to the $5/2^+$ ground state and E2 admixture in the cascade transition to the $5/2^+$ first excited state were established. A J^π assignment of $1/2^+$ for the 2.80 Mev ^{21}Ne state is confirmed, and the existence of a 10 ± 1% E2 cascade de-excitation to the $5/2^+$ 0.353 Mev state was established. Further data indicates that $J \geq 5/2$ and $7/2$ for the 2.87 and 3.67 Mev ^{21}Ne states, respectively, and strongly imply that the 3.74 and 3.57 Mev states in ^{21}Ne and ^{21}Na, respectively, are mirror analog $5/2^+$ states. An unambiguous J^π assignment of $3/2^-$ is evidenced for the 4.73 Mev ^{21}Ne state. Available evidence supports the general validity of a strong-coupling collective model interpretation of the ^{21}Na structure. (auth)

8453 DIFFERENTIAL RANGE STUDY OF Na^{24} FORMED BY 2.9-Gev PROTON IRRADIATION OF LIGHT ELEMENTS. Norbert T. Porile (Brookhaven National Lab., Upton, N. Y. and McGill Univ., Montreal) and Shigeo Tanaka. Phys. Rev., 137: B58-63(Jan. 11, 1965). (BNL-8184)

Thin targets (≈50 $\mu g/cm^2$) of copper, vanadium, and chlorine (Saran) were irradiated with 2.9-Bev protons. Products recoiling at 90° to the beam were collected in a stack of thin plastic films, at a geometry of 2π. The range distributions of ^{24}Na were determined by radiochemical separation, and energy spectra were deduced from the measurements. The mean energies of ^{24}Na from copper, vanadium, and chlorine are 8.2, 6.1, and 4.3 Mev, respectively. The observed energy spectra were compared with the results of Monte Carlo cascade-evaporation calculations, and very good agreement was obtained for copper and vanadium. The calculation predicts significantly larger recoil energies than observed in the case of the chlorine target. It is concluded that this is due to an overestimate of the transverse component of momentum imparted to the residual nuclei in the cascade process. (auth)

8454 L/K X-RAY INTENSITY RATIO IN THE DECAY OF Tl^{204} AND L-SHELL FLORESCENCE YIELDS OF Hg. P. Venugopala Rao and Bernd Crasemann (Univ. of Oregon, Eugene). Phys. Rev., 137: B64-70(Jan. 11, 1965).

The Hg L/K x-ray intensity ratio in the decay of ^{204}Tl was determined with proportional and scintillation counters, using Ag K x rays for intercomparison of detector efficiencies. Beta rays were stopped before they entered the detectors. The shape of the bremsstrahlung spectrum under the x-ray peaks was determined with ^{36}Cl beta rays. The result is $I_L/I_K = 0.52 \pm 0.02$. The mean L fluorescence yield of Hg following electron-capture decay of ^{204}Tl then is $\bar{\omega}_L = 0.40 \pm 0.05$, if the L/K capture ratio is 0.42 as measured by Joshi and by Leutz and Ziegler. The partial L-shell fluorescence yield of Hg following K_α x-ray emission was measured as $\omega_{KL} = 0.41 \pm 0.02$ from K and L x-ray coincidences. The partial L-shell fluorescence yield of Hg following L capture only of ^{204}Tl is $\omega_{LL} = 0.39 \pm 0.06$, as determined by the same method. (auth)

8455 SHORT-RANGE CORRELATIONS AND THE THREE-BODY BINDING ENERGY. Frank Tabakin (Columbia Univ., New York). Phys. Rev., 137: B75-9(Jan. 11, 1965). (TID-21182)

The separable-potential approach of Mitra is extended by introducing an additional interaction which yields two-nucleon S-wave phase shifts to 340 Mev. A calculation of the exact binding energy and wave function of a simplified three-body system is used to determine the role of short-range correlations and the associated off-energy-shell matrix elements of the interaction It is found that the three-body binding energy ranges from 9.33 to 8.40 Mev; the larger value is calculated using a two-body interaction fitting low-energy data only, while the smaller value results from including a hard-shell repulsion. A smooth repulsion, which is equivalent to the hard shell in the two-body problem, yields a three-body binding energy of 8.79 Mev. (auth)

8456 ASYMMETRIES FROM SCATTERING 2.8- TO 4.7-Mev d-d NEUTRONS BY CARBON. B. E. Wenzel and M. F. Steuer (Univ. of Georgia, Athens). Phys. Rev., 137: B80-2(Jan. 11, 1965).

Polarized neutrons with energies ranging from 2.8 to 4.7 Mev were scattered from carbon in the plastic scintillator NE102 and detected by a carbon recoil coincidence technique. Right-left ratios of the scattered intensities were measured at a mean scattering angle of 135°c.m. The energy dependence of the polarization $P_2(135°,E)$ was determined from the measurements and compared, where applicable, to curves predicted from published phase shifts. The data indicate that the phase shifts require modifications and suggest that the effect of the resonance at 4.3 Mev may be important. (auth)

8457 OPTICAL-MODEL INTERPRETATION OF AVERAGE TOTAL NEUTRON CROSS SECTIONS IN THE kev REGION. A. P. Jain, R. E. Chrien, J. A. Moore, and H. Palevsky (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 137: B83-9(Jan. 11, 1965). (BNL-8173)

Total neutron cross sections for the elements Nb, Mo, Rh, Ag, Cd, and In in the range of 11 to 101 kev were measured using the Brookhaven fast chopper at the NRU reactor, Chalk River, Canada. The data, after correction for sample thickness effects, are interpreted in terms of a spherical optical-model potential. The comparison of the data with the model indicates that the potential is more likely to be of the surface-absorption type rather than of the volume-absorption type. Some evidence of fluctuations

in S-wave strength functions from nuclide to nuclide, instead of the smooth variation predicted by the optical model, was found. It is suggested that the parameters of the potential well, chiefly the imaginary part, may be different for S- and P-wave neutrons. (auth)

8458 PROMPT NEUTRONS FROM THORIUM PHOTOFISSION. C. P. Sargent, W. Bertozzi, P. T. Demos, J. L. Matthews, and W. Turchinetz (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 137: B89-101(Jan. 11, 1965). (TID-20606); (MIT-2098-80)

The distribution in angle and velocity of the prompt neutrons from the bremsstrahlung-induced photofission of ^{232}Th in the photon energy region near threshold was measured. Using knowledge of the fission-fragment angular distribution, the data were analyzed in terms of the neutron distribution relative to the fragment axis. The fraction of neutrons which are not emitted by fully accelerated fragments was estimated at 0.07 ± 0.09. Assuming isotropic neutron emission in the fragment center-of-mass frame, an average energy $\overline{\eta}$ = 1.14 ± 0.06 Mev and a second central moment $\sigma^2(\eta) = (0.77 \pm 0.06)\overline{\eta}^2$ was determined for the neutron energy spectrum. If it is represented by an evaporation-type spectrum with some distribution of temperatures, no significant contribution from temperatures equal to or greater than $\overline{\eta}$ exists. A similar analysis was made of data on prompt neutrons from the spontaneous fission of ^{252}Cf obtained by Bowman, Thompson, Milton, and Swiatecki, and was compared with results for ^{232}Th photofission. (auth)

8459 NUCLEAR SPECTROSCOPY WITH TWO-NUCLEON TRANSFER REACTIONS. Norman K. Glendenning (Univ. of California, Berkeley). Phys. Rev., 137: B102-13(Jan. 11, 1965). (UCRL-11353)

The aspects of two-nucleon transfer reactions that depend on nuclear structure can be isolated in structure amplitudes G, which do not depend on the kinematics or scattering states of the reaction. The calculation of these amplitudes from microscopic nuclear models is illustrated in a number of examples. The structure amplitudes measure the parentage and the degree to which a nuclear state possesses the particular correlations predicated by the fact that the pair is transferred to or from a light nuclide which itself has definite and simple correlations among its nucleons. Several specific nuclear reactions are considered in some detail, and the structure amplitudes for many nuclear levels are given. (auth)

8460 $C^{12}(\alpha,d)N^{14}$ REACTION. Richard H. Pehl, Ernest Rivet, Joseph Cerny, and Bernard G. Harvey (Univ. of California, Berkeley). Phys. Rev., 137: B114-19 (Jan. 11, 1965). (UCRL-11498)

The energy spectra of deuterons from the $^{12}C(\alpha,d)^{14}N$ reaction were studied up to an excitation of 21 Mev. The reaction was induced by 53-Mev alpha particles from the Berkeley 88-in. spiral-ridge cyclotron, and the reaction products were distinguished by a new type of particle identifier. The observed selectivity of final state population is correlated with the predicted configurations for many ^{14}N levels and several new assignments are made. (auth)

8461 HYPERFINE STRUCTURE OF Hg^{193*}, Hg^{195}, AND Hg^{195*} BY ZEEMAN-LEVEL CROSSINGS. Winthrop W. Smith (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 137: A330-9(Jan. 18, 1965).

Hyperfine-structure measurements by optical detection of Zeeman-level crossings in the 6s6p $^3P_1$ state were made with natural-linewidth precision in three radioisotopes of mercury. The magnetic dipole (A) and electric quadrupole (B) interaction constants in Mc implied by these measurements (without second-order hyperfine corrections, but including second-order Zeeman and cross-Zeeman hyperfine corrections) are ^{195}Hg (9.5-h half-life), A ($^3P_1$) = 15813.46 ± 0.23, ^{195*}Hg (isomer, 40 h), A ($^3P_1$) = −2368.04 ± 0.08, B ($^3P_1$) = −782.45 ± 0.86; and ^{193*}Hg (isomer, 11 h), A ($^3P_1$) = −2399.69 ± 0.06, B ($^3P_1$) = −724.8 ± 90.0. The g_J factor for the $^3P_1$ state of ^{199}Hg is obtained from a new level-crossing measurement. The value, including second-order Zeeman and Zeeman-hyperfine corrections, is $g_{J'}$ = 1.486118 ± 0.000016; 37 × 10^{-6} of this is the total contribution from g_I and the second-order corrections. This value is in substantial agreement with a recent measurement on the even Hg isotopes. The measured ratio of the A factors of ^{195}Hg and ^{199}Hg with all second-order corrections (resulting from interaction with neighboring fine-structure levels) included is combined with the value for the ratio of the magnetic moments in an external field obtained by Walter and Stavn to yield the Bohr-Weisskopf hfs anomaly between ^{195}Hg and ^{199}Hg, which is calculated to be $^{195}\Delta^{199}$ ($^3P_1$) = 0.1476 (76)%. The contribution to the anomaly from the $s_{\frac{1}{2}}$ electron is extracted and used to estimate admixture coefficients in the single-particle model of the nucleus with configuration mixing. These turn out to be satisfactorily small for the configurations assumed. (auth)

8462 RELAXATION EFFECTS IN NUCLEAR MAGNETIC DOUBLE RESONANCE. D. B. Nageswara Rao (Harvard Univ., Cambridge, Mass.). Phys. Rev., 137: A467-75(Jan. 18, 1965).

A general method, based on the density-matrix formalism of magnetic resonance given by Bloch and using the notational simplicity of Redfield, is described for analyzing relaxation and coherence effects in nuclear magnetic double resonance. The method consists of transforming the equation of motion of the spin density matrix to a coordinate system rotating at the angular frequency of the strong irradiating field. The effect of the strong field is then calculated in the absence of the observing field. The effect of the observing field is calculated by obtaining a steady-state solution of the equation of motion. The method is briefly illustrated for the case of a single nucleus of spin ½. (auth)

8463 DYNAMIC NUCLEAR ENHANCEMENT IN METALLIC SODIUM. Jonathan F. Reichert and Jonathan Townsend (Washington Univ., St. Louis). Phys. Rev., 137: A476-82(Jan. 18, 1965).

A double-resonance spectrometer was constructed capable of making accurate measurements of the dynamical variables expressed in the master equation governing the time evolution of the dynamic nuclear enhancement of a single sodium sample. This system could measure the rate of rise of the nuclear polarization after the onset of saturation, the rate of decay of the polarization after the saturation was removed, and the nuclear T_1 by the standard 180°−90° pulse method. It was found that each of these processes had the same time constant T_1 = 13.2 ± 0.2 msec within experimental error, in agreement with theory. The steady-state enhancement as a function of electron saturation gave a value of the leakage coefficient f to be 0.88 ± 0.05 (at 29°C). The values of T_1 and f enable one to calculate T_1^e (the spin-lattice relaxation time due to the conduction-electron-nuclear contact interaction) to be 14.9 ± 0.8 msec. These data demonstrate that the electron-nuclear contact interaction is the dominant mode of nuclear relaxation for sodium at room temperature. (auth)

8464 ELECTRON SPIN RESONANCE OF Mo^{5+} IN $CaWO_4$. G. H. Azarbayejani and A. L. Merlo (Bendix Corp., Southfield, Mich.). Phys. Rev., 137: A489-90(Jan. 18, 1965).

Electron-spin-resonance measurements of Mo^{5+} in $CaWO_4$ were carried out at about 4.2°K and 9.2 Gc. The g values parallel and perpendicular to the c axis are 1.987 and 1.887, respectively. The hyperfine-splitting constants for the two isotopes (^{95}Mo and ^{97}Mo) of molybdenum in units of 10^{-4} cm^{-1} are $A_{\parallel}^{(95)}$ = 8.39, $A_{\perp}^{(95)}$ = 41.18, $A_{\parallel}^{(97)}$ = 8.64, and $A_{\parallel}^{(97)}$ = 45.52. (auth)

8465 HYPERFINE INTERACTIONS IN THE GROUND STATE AND 22-kev STATE OF Sm^{149} IN FERRIMAGNETIC COMPOUNDS OF SAMARIUM. S. Ofer (Hebrew Univ., Jerusalem), E. Segal, I. Nowik, E. R. Bauminger, L. Grodzins, A. J. Freeman, and M. Schieber. Phys. Rev., 137: A627-38(Jan. 18, 1965).

Hyperfine interactions in $SmFe_2$, $SmFeO_3$, Sm metal, and particularly in samarium iron garnet, SmIG, were studied at various temperatures using the Mössbauer effect in

^{149}Sm. Large magnetic hyperfine interactions are observed in SmIG even at room temperature, in contrast with the observed Sm sublattice magnetization. A value of $(1.55 \pm 0.25) \times 10^6$ Oe was found for the magnetic field acting on the Sm nucleus in samarium iron garnet at 20°K. For $SmFeO_3$ an upper limit of 10^6 Oe was found for H_{eff} at 77°K. The experimental results support an assignment of a spin $\frac{5}{2}$ for the 22-kev level and yield a value of 1.26 ± 0.04 for the ratio of the magnetic moments of the 22-kev state and the ground state. A small isomeric shift, -0.9 ± 0.3 mm/sec, was found between Sm metal and Sm_2O_3 absorbers at 300 and 80°K. Upper limits for H_{eff} in $SmFeO_3$ were found to be 4×10^5 Oe 16°K, 1.9×10^5 Oe at 80°K, and 1.5×10^5 Oe at 300°K. The origin of the temperature dependence of the hyperfine fields acting on Sm nuclei in SmIG is discussed, including the effects of the molecular exchange field and the electrostatic crystalline field. Comparison is also made with the theory of magnetization of Sm sublattices. Exchange effects are found to be strong and dominant at high temperatures, whereas at low temperatures crystalline-field effects are found to predominate. These results are in fair agreement with theoretical predictions, if it is assumed that at low temperatures H_{eff} is determined mainly by the splitting of the quartet $^8\Gamma$ ground state (which is the lowest of the two levels into which the $^6H_{5/2}$ ground state is split by a cubic electric field) by the exchange interaction. (auth)

8466 EFFECT OF PROTON CHANNELING AT 2.8 Mev ON THE $Cu^{65}(p,n)Zn^{65}$ REACTION RATE IN A SINGLE CRYSTAL OF Cu. M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Rev. Letters, 13: 756-60(Dec. 21, 1964). (AERE-R-4726)

A Cu crystal was bombarded with 2.8-Mev protons and the rate of neutron emission studied as a function of orientation to investigate the effect of proton channeling on the $^{65}Cu(p,n)$ reaction rate. The $^{65}Cu(p,n)$ reaction has a threshold near 2.1 Mev and a cross section rising through 0.1 barn at about 3 Mev. It was assumed that a significant fraction of protons entering a suitably oriented Cu crystal would become channeled and would slow down below 2.1 Mev with a reduced chance of reactive nuclear encounters. It is found that measurements of nuclear charged-particle cross sections are dependent on the crystalline nature of the target. (C.E.S.)

8467 CALCIUM-37. J. C. Hardy and R. I. Verrall (McGill Univ., Montreal). Phys. Rev. Letters, 13: 764-6(Dec. 21, 1964).

The observation of ^{37}Ca by measurements on the delayed protons following its β^+ decay is reported. The lifetime and other properties of the ^{37}Ca decay were measured. A proposed decay scheme is included. (C.E.S.)

8468 NEW DELAYED-PROTON EMITTERS: Ti^{41}, Ca^{37}, AND Ar^{33}. P. L. Reeder, A. M. Poskanzer, and R. A. Esterlund (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 13: 767-9(Dec. 21, 1964).

Three new nuclides, ^{41}Ti, ^{37}Ca, and ^{33}Ar were observed to be delayed proton emitters of the type that undergo beta decay to proton unstable states of daughter nuclei. The nuclides were produced by the $(^3He,2n)$ reaction in the external beam of the 60-in. cyclotron. The maximum energy of the beam was 31.8 Mev and the average intensity was about 0.1 μ amp. Targets of S, ^{36}Ar, and Ca were used. (C.E.S.)

8469 NEUTRON DIFFRACTION BY PARAMAGNETIC Mn_5Ge_3. R. Ciszewski (Technical Univ., Warsaw). Phys. Status Solidi, 7: 1015-18(1964).

The differential cross section of metallic manganese for paramagnetic scattering is obtained from the background scattering observed for the compound Mn_5Ge_3. The variation of the magnetic amplitude form factor of metallic manganese with scattering angle is found to be quasi-identical with that of Mn^{2+}. The radial distribution of the electrons in the 3d shell of metallic manganese is calculated from the amplitude form factor. (auth)

8470 THE L CAPTURE FRACTION AND THE TOTAL TRANSITION ENERGY IN THE DECAY OF ^{207}Bi TO ^{207}Pb. A. De Beer, H. P. Blok, and J. Blok (Vrije Universiteit, Amsterdam). Physica, 30: 1938-42(Oct. 1964).

Using a thin source between two adjacent proportional counters the L capture fraction P_L in the decay of ^{207}Bi to the 2338 kev level in ^{207}Pb was measured. L x rays and L Auger electrons were measured in a 4π geometry in coincidence with the 1770 kev γ radiation. The result is $P_L = (66.3 \pm 1.4)\%$. From this the transition energy to this level is calculated to be $E_0 \cong 62.4$ kev. (auth)

8471 QUASI-SPIN IN LS COUPLING. B. H. Flowers and S. Szpikowski (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 84: 673-9(Nov. 1964).

The quasi-spin formalism put forward in the case of jj coupling by Kerman and by Helmers is extended to the case of LS coupling including isotopic spin. The quasi-spin operators generate the rotation group in eight dimensions of which a six-dimensional rotation sub-group is found to give rise to a classification of states equivalent to the supermultiplet scheme of Wigner. The energy eigenvalues of a charge-independent pairing hamiltonian are given for the pure configuration l^n in terms of the Casimir operators of these two groups. (auth)

8472 A MODEL FOR NUCLEAR THRESHOLD LEVELS. F. C. Barker (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 84: 681-7(Nov. 1964).

A model based on the R-matrix theory of nuclear reactions is shown to predict that near thresholds of channels with small barriers there should be an increased density of levels with large reduced widths. The experimental evidence for such an effect is considered. (auth)

8473 SEMI-EMPIRICAL MASS FORMULA FOR COMPRESSIBLE NUCLEI. Masami Yamada (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 32: 512-41 (Oct. 1964).

A nuclidic mass formula in which the compressibility of the nuclear matter is taken into account is proposed. The values of parameters in the formula are determined from comparison with the experimental data on nuclidic masses, nuclear sizes, and isotope shifts. A significant improvement is made in explaining the gross feature of the β-stability line, provided that a compressibility which is much larger than those evaluated in the current theories of nuclear matter is used. Corresponding to the large compressibility, the density of the ground state of the hypothetical infinite nuclear matter in which, in addition to the nuclear forces, only such a part of the Coulomb energy as does not appear in the Fermi gas model is taken into account, is considerably larger than the observed densities of the real nuclei. (auth)

8474 THEORY OF (α,d) STRIPPING REACTION ON LIGHTER NUCLEI. [PART] I. Bunryu Imanishi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 32: 542-64(Oct. 1964).

The mechanism of the (α,d) stripping reaction for lighter nuclei is investigated in comparison with that of the (d,p) or the (d,n) stripping reaction. Theoretical considerations and numerical calculations for the case of s-d shell of the product nucleus reveal that the effect of finite size of the α particle is essential in this reaction. Further, it is shown that the probability that the transferred nucleons make a cluster-like state is very high because of the fact that they are tightly bound in the incident α particle. It is emphasized that further studies of the correlation between the captured nucleons in the product nucleus will be very important. (auth)

8475 SELF-CONSISTENT FIELD IN SELF-BOUND FINITE NUCLEUS. Tatuya Sasakawa (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 565-97(Oct. 1964).

By means of the antisymmetrized product of plane waves, the shell model wave function $\mathcal{N}[\prod_{i=1}^{A} u_{\alpha_i}(i)]$ in the nucleon system which is self-bound is derived. Each wave function $u_\alpha(i)$ has the tail exponentially small at large distances from the origin. In the final result, the self-consistent field is given by $U_i = \sum_{j=1}^{A} (u_{\alpha_j}(j)|t_{ij}|u_{\alpha_j}(j))$. Here the t-matrix has just the same meaning as the Brueckner t-matrix but with a difference in the boundary condition of the Green's function in the t-matrix. The t-matrix is

so defined that it vanishes at large distances from the origin. Therefore, it is suited for treating the finite system. It has a further advantage that the Neumann series converges for nuclear potentials. Three points are essential in derivation: the Pauli principle, the nuclear force is weak, having only one bound state in free space, and the number of constituent particles is very large so $1/A \ll 1$. The extension of the method to the independent pair model is made. In the limit of infinite matter, the precise equivalence of the method and the Brueckner method is shown for a weak interaction. (auth)

8476 INVESTIGATION OF THE K RADIATION FROM ELECTRON CAPTURE BY ^{71}Ge WITH A DIFFRACTION SPECTROMETER WITH BENT CRYSTAL. W. von Oertzen (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 182: 130-6(1964). (In German)

The intensity of satellites in the gallium x rays emitted in K-capture of ^{71}Ge was measured and found to be $(1.3 \pm 0.5) \times 10^{-4}$ per K-capture. A curved-crystal x-ray spectrometer with a radius of curvature of 27 cm was used for the measurement. The satellites are found to be due to double ionization of the K-shell accompanying K-capture as described by the theory of Primakoff and Porter. The theoretically calculated intensity of x-ray satellites emitted due to double ionization of the K-shell— 0.9×10^{-4} per K-capture— is in fair agreement with experiment. (auth)

8477 GAMMA TRANSITIONS AND ENERGY LEVELS IN ^{165}Dy. O. W. B. Schult, B. P. Maier, and U. Gruber (Technische Hochschule, Munich and Atomenergikommissiones Forsøgsanlaeg, Risø, Roskilde, Denmark). Z. Physik, 182: 171-93(1964). (In German)

Measurements were made of 220 neutron capture gamma rays of ^{165}Dy with the Risø curved crystal spectrometer. The intense transitions permitted the construction of a level scheme for this odd N nucleus. The rotational bands $K = 7/2^+[633]$, $K = 1/2^-[521]$ and $K = 5/2^-[512]$ were precisely localized, including the spin $11/2$ states. Gamma-vibrational bands built on these Nilsson orbits were observed with their band heads at 538.6, 573.5, and 570.2 kev. The $I = 5/2$ term at 533 kev can be considered as the $5/2^-$ [523] Nilsson state. The branching ratios allowed the determination of $(g_K - g_R)^2$-factors for the [633], [521], and [512] bands and yielded E 1-hindrance factors. A table of the γ spectra is presented. (auth)

8478 ON THE RATIO OF THE NUCLEAR QUADRUPOLE MOMENTS OF THE TWO MOLYBDENUM ISOTOPES ^{95}Mo AND ^{97}Mo. Johannes Kaufmann (Universität, Tübingen, Ger.). Z. Physik, 182: 217-26(1964). (In German)

The NMR line widths of the isotopes ^{95}Mo and ^{97}Mo were measured in liquids, where the relaxation time is determined mainly by electric interaction. From the ratio of the line widths $\delta H_{97}/\delta H_{95} = 83$, the ratio of the nuclear quadrupole moments $Q_{97}/Q_{95} = 9.2$ could be derived. The instrumentally limited range of line widths which could be investigated was 0.1 to 10 G. The line widths of both isotopes were measured in this whole region in an aqueous solution of K_2MoO_4, the viscosity of which was varied by adding different amounts of cane sugar. The line width ratio was evaluated by a graphical method. (auth)

8479 PRODUCTION OF Li^8 FRAGMENTS IN THE INTERACTION BETWEEN 9 Gev PROTONS AND LEAD NUCLEI. V. Gayevski, P. A. Gorichev, and N. A. Perfilov. Zh. Eksperim. i Teor. Fiz., 47: 1178-84(Oct. 1964). (In Russian)

The production probability, energy spectrum, and angular distribution of ^{8}Li fragments produced in disintegration of lead nuclei by 9-Bev protons are obtained. The experimental data are compared with the predictions of the evaporation theory. The best agreement is obtained with the following parameters: temperature T = 14.9-Mev, barrier V = 9.6 Mev. (auth)

8480 CHARACTERISTICS OF THE F^{19} NUCLEAR LEVELS FOR EXCITATION ENERGIES BETWEEN 8.5 AND 10.5 Mev. K. V. Karadzhev, V. I. Manko, and F. E. Chukreev. Zh. Eksperim. i Teor. Fiz., 47: 1185-98(Oct. 1964). (In Russian)

The $^{18}O(p,\alpha)^{15}N$ reaction was studied in the 1100 to 2600 kev proton energy range. Approximately 120 angular distributions were obtained. The distributions are expanded into Legendre polynomials. The analysis shows that the main contribution to the reaction cross section is from states corresponding to total angular momenta and parities of $1/2^+$ and $3/2^+$. The characteristics of 14 resonances corresponding to excited ^{19}F states with energies between 9 and 10.5 Mev are also obtained. The reduced α-particle widths possess quite a narrow distribution with a center near 5×10^{-3} (in $3\hbar^2/2\mu r^2$ units). (auth)

8481 LIFETIME OF THE 114-kev LEVEL IN THE Pr^{139} NUCLEUS. A. A. Sorokin (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 47: 1232-4(Oct. 1964). (In Russian)

The half life of the 114-kev first-excited state in the ^{139}Pr nucleus is measured by the delayed coincidence method with aid of a time-to-pulse height converter. The value obtained is $T_{1/2} = (2.5 \pm 0.2) \times 10^{-9}$ sec. This corresponds to retardation of M1 transitions to the ground state by a factor f = 310 as compared with the Weisskopf's single-particle estimation. Forbidden M1 transitions to the ground states of the neighboring isotopes ^{141}Pr and ^{143}Pr are characterized by approximately the same retardation factor. (auth)

8482 BREMSSTRAHLUNG IN SCATTERING OF NEUTRINOS ON NUCLEI. M. S. Dubovikov (Inst. of Physics and Tech., Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1496-1502(Oct. 1964). (In Russian)

The bremsstrahlung process during the scattering of neutrinos on nuclei is considered. Expressions are obtained for the angular and spectral distributions of quanta and for the total cross section in the case when the neutrino energy is much smaller or much larger than the momentum at which the nuclear form factor appreciably decreases. (auth)

8483 EFFECT OF THE SURFACE LAYER AND DEFORMATION OF THE NUCLEUS ON THE REDUCED E0 CONVERSION PROBABILITY. L. A. Borisoglebskii. Zh. Eksperim. i Teor. Fiz., 47: 1575-80(Oct. 1964). (In Russian)

The dependence of the electron E0 conversion probability on the parameters α, β, and γ^0 determining the thickness of the surface layer and deformation of the nucleus is investigated. (auth)

8484 EFFECTS OF PAIRING FORCE ON THE INTRINSIC EXCITATION IN STRONGLY DEFORMED NUCLEI. Li-ming Yang and Chin-yen Tseng (Peking Univ.). Wu Li Hsueh Pao, 20: 846-62(Sept. 1964). (In Chinese)

A new approximate method for treating the nn and pp pairing force in nuclei is presented. In this method the difficulties connected with the application of BCS-Bogolubov method to nuclei such as the non-conservation of the number of particles, the appearance of spurious states, and non-orthogonality between wave functions of different excited states are avoided. But the method can be conveniently adopted only when the number of particles n and the number of levels Ω considered are small ($n \lesssim 10$, $\Omega \lesssim 10$). Also the approximation of this method is good only under such conditions. In this method the many-body nature of the excitation is displayed explicitly without introducing the conception of quasi-particles. The excitation of the system can be divided into two classes. The first class of excitation is a kind of single particle excitation embedded in a many-body system under the action of the pairing force. This would correspond to the excitation of a single quasi-particle $\alpha^+_{\nu}\alpha_{\nu_0}$ or to two quasi-particle excitation of the type $\alpha^+_{\nu}\beta^+_{\nu}$, $\alpha^+_{\nu}\alpha^+_{\nu'}$ ($\nu' \neq \nu$) etc. in the BCS-Bogolubov method. The second class of excitation is a pair excitation in which the distribution of the conjugated pairs of particles among the levels is altered. This type of excitation would correspond to superposition of quasi-particle excitations of the type $\alpha^+_{\nu}\beta^+_{\nu}$, $\alpha^+_{\nu}\beta^+_{\nu}\alpha^+_{\mu}\beta^+_{\mu}$. Also examined is the effect of pairing force on the β- and γ-transition probability in the new formalism. In general, β-transition is retarded by the pairing force while in γ-transition the

effect of pairing force varies according to the nature of the relative excitation between the initial and final states. When the relative excitation is of the first class, the transition is retarded to various extent, depending on the nature of the γ-transition. If the relative excitation is of the second class, the transition is forbidden when the pairing force is not in action, and is allowed only for electric transition arising from the charge-current distribution when the pairing force is present. Finally this method is applied to investigate the effect of pairing force on the intrinsic spectra and β-transition in ^{178}Hf as an example. (auth)

8485 ANGULAR DISTRIBUTION OF THE FISSION FRAGMENTS AND THE STRUCTURE AT THE SADDLE POINT. Yei-zhung Zhu and Tse-ching Lee. Wu Li Hsueh Pao, 20: 1003-18(Oct. 1964). (In Chinese)

On the basis of the general expression of the scattering matrix between two particles with spin, derived by Jacob and Wick, by means of certain approximations, the experimental data of the angular distribution of the fission fragments from ^{230}Th, ^{232}Th, ^{234}U, ^{236}U, and ^{238}U, bombarded by neutrons whose energy is in the region near the fission threshold were analyzed. The results of this analysis show: The angular distribution of the fission fragments, in the region near the threshold, can be explained by a few rotational bands (every band has a definite parity) above the saddle point. These rotational bands are consistent with the asymptotic energy levels of Nilsson. Furthermore, based on the idea that the barrier of the saddle point of the symmetric fission is higher than that of the asymmetric, the correlation between the anisotropy of the angular distribution of fission fragments and its mass ratio is discussed. (auth)

8486 THE POLARIZATION OF 1.33 Mev GAMMA RAYS ELASTICALLY SCATTERED BY LEAD. Ross Alan Williams. Thesis, Toronto, Univ. of Toronto, 1963. 142p.

An experiment to measure the polarization of 1.33-Mev ^{60}Co gamma rays elastically scattered by lead at angles between 40 and 80 degrees is described. A total absorption Compton polarimeter having an energy resolution of about 6.5% at 1.33 Mev and a resolving time of 16×10^{-9} seconds was used to make the measurements. The pulse-height spectra obtained with this instrument were corrected for random coincidences by subtracting the spectrum obtained with a copper target from that of the lead target. The corrected spectra were then analyzed by fitting with a spectrum due to unscattered ^{60}Co radiation to represent elastic scattering, plus a calculated spectrum for inelastic Compton scattering from the tightly bound electrons in the inner shells of the lead atoms. It was found necessary to extend these calculations to include the L shell electrons. The analysis of the results was done on the IBM 7090 computer at the University of Toronto. The polarization versus angle distribution resulting from this experiment does not disagree with that predicted for the other two kinds of elastic scattering, namely, Rayleigh and nuclear Thomson scattering, and so no evidence for the existence of Delbrück scattering is found. An effect of Delbrück scattering on the polarization of up to 20% of the total elastic scattering is not ruled out, however, as uncertainties of this order exist in the calculations for Rayleigh scattering. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8487 PROTON EMISSION IN 42-Mev ALPHA PARTICLE BOMBARDMENTS OF SEVERAL ELEMENTS. Richard Wilbur West. Thesis, Seattle, Univ. of Washington, 1963. 262p.

Measurements were made of the energy spectra, angular distributions, and absolute cross sections of protons emitted from bombardments of ^{59}Co, ^{58}Ni, ^{60}Ni, ^{62}Ni, ^{63}Cu, ^{65}Cu, Nb, Rh, Pd, and Pt targets by 42-Mev alpha particles. A dE/dX–E scintillation telescope was used in conjunction with an x, y oscilloscope to detect and identify protons in the energy range from 2 to 40 Mev. The data were compared to predictions of the statistical model of nuclear reactions. A computer code was written to generate the expected proton energy spectra based on this model. The cascade was restricted to neutron and proton emission only, and a level density of the form $[\exp 2\sqrt{a(U-\delta)}]/(U-\delta)^2$ was used. Except for Pt, the calculated and experimental energy spectra matched in slope over a relatively wide intermediate energy region. This made it possible to separate the data into compound nuclear and non-compund nuclear portions. It was found that compound nuclear events account for 90% of the proton yield for targets in the Ni region, 65% of the proton yield for targets in the Rh region, and probably less than 6% of the proton yield for Pt. The non-compound nuclear component exhibits a relatively constant yield of ~85 mb for all the targets studied. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8488 STUDY OF THE DETAILED FORM OF RESONANCE YIELD CURVES FROM SEMI-THICK TARGETS OF ALUMINUM. James Gust Skofronick. Thesis, Madison, Wis., Univ. of Wisconsin, 1964. 129p.

The major portion of this work involved measurements of the detailed shapes of yield curves from semi-thick aluminum targets over the 992-kev ^{27}Al(p,γ)^{28}Si resonance reaction with attempts to find what information might be obtained from such curves. Some additional yield curves for thick targets were obtained to determine effects on yield curves of oxygen and nitrogen gases. The experimental results were compared to calculated yield curves computed by Monte Carlo techniques for an assumed collision spectrum based on the Born approximation. The aluminum targets were prepared under conditions that minimized effects of contamination. The data from these targets were taken through the use of an electronic device which swept the voltage on the target in a stair-step manner keeping account of the yield values for each step. The device also had the function of correcting for energy fluctuations in the beam from the electrostatic generator. Thick-target results show that introducing oxygen or nitrogen gases into the vacuum system can cause surface contamination of the targets so that the shape of the yield curves are changed. It was found that semi-thick target yield curves appear to be less sensitive to the collision spectrum than thick-target yield curves. The limitations on the semi-thick targets were largely due to target nonuniformities, and results indicate that all of the semi-thick targets examined were nonuniform, with the thicker targets showing less nonuniformities than the thinner ones. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8489 A SEARCH FOR THE PHOTODEUTERON REACTION IN COPPER. James Anthony Shannon. Thesis, Philadelphia, Univ. of Pennsylvania, 1963. 104p.

The ratio of photodeuteron to photoproton yields in copper is investigated. Bremsstrahlung irradiation of foil targets was carried out at peak energies of 24, 30, and 40 Mev. Each exposure took several hours on the Yale Electron Accelerator. The protons and deuterons produced were measured in an Omegatron type mass spectrometer. Details of operation of this device are included. Deuterons were definitely found only in the target exposed to 40-Mev radiation. The yield ratio at this energy was estimated as 0.00017. Upper limits of this ratio at 24 and 30 Mev were measured as 0.0006 and 0.00014 respectively. Calculations of the compound nucleus evaporation theory are reported. They indicate yield ratios several orders of magnitude greater than those actually found. The suggestion is made that the deuteron does not exist as a nuclear subunit. The direct photointeraction theory of Madsen and Henley (Nucl. Phys., 33: 1(1962)), is estimated to give yield ratios of the order of 0.00003 at the energies investigated. These ratios are not inconsistent with the results. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8490 PHOTONUCLEAR MEASUREMENTS WITH NEUTRON-CAPTURE GAMMA RAYS UTILIZING DIRECT NEUTRON DETECTION. Lawrence Green. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 106p.

Thermal-neutron capture gamma rays were used to measure photoneutron cross sections for the isotopes ^{181}Ta, ^{6}Li, ^{7}Li, ^{13}C, and ^{10}B in the energy range 5.4–10.8 Mev. The gamma rays were produced by neutron capture in a series of sources placed adjacent to a nuclear reactor core. The gamma rays were admitted into the experimental area

after passing through an air tube, one foot of water, and three feet of paraffin. Copper collimators were used to reduce the beam diameter to about 1 inch. The neutron yield was measured by means of a 4π counter employing four $^{10}BF_3$ detectors. The flat-response position of each detector with respect to the central axis of the counter was determined using three calibrated neutron sources. Flux measurements were made with a 4-inch diameter by 6-inch long NaI(Tl) crystal spectrometer. The results obtained are compared with recent work utilizing bremsstrahlung beams and time-of-flight techniques. In the regions where the data overlap, the agreement is generally good. In addition, the present work yielded additional information for ^{7}Li in the region near threshold, and information on radiative widths of levels in ^{7}Li and ^{10}B. For 28 of the 38 cross sections measured, the uncertainty is 10–20%. The uncertainties of the remaining cross sections vary from 30% to 100% and are usually the result of very high statistical errors due to low neutron counting rates. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8491 PROTON CAPTURE RADIATION FROM Ca^{40} IN THE REGION OF THE GIANT RESONANCE. Joseph Carl Hafele. Thesis, Chicago, Univ. of Illinois, 1964. 120p.

The 90° differential cross sections for radiative proton capture to the ground and first four excited states of ^{40}Ca were measured for proton energies from 6 to 15 Mev, corresponding to ^{40}Ca excitation energies of 14 to 23 Mev. A giant resonance near the excitation energy of 19 Mev with a width of about 3 Mev occurs in the $^{39}K(p,\gamma_0)^{40}Ca$ reaction. The giant resonance is split into eight resolved fine structure peaks between 18 and 22 Mev and subsidiary peaks appear below the giant resonance at 15.2 and 16.2 Mev. This experiment extends the region of excitation energies studied in previous experiments, and the results are in agreement in the region of overlap. The inverse differential photoproton cross section for the $^{40}Ca(\gamma,p_0)^{39}K$ reaction is determined by applying the principle of detailed balance. The excitation energy and strength of the resonance in this partial photoproton cross section are then compared with several theoretical calculations of the energy and dipole strength for the dipole states in ^{40}Ca. The $^{40}Ca(\gamma,p_0)^{39}K$ differential cross section is also compared with a measurement of the $^{40}Ca(\gamma,n)^{39}Ca$ cross section. Both of these cross sections display similar fine structure peaks. The pulse height spectra from the gamma-ray spectrometer show a secondary gamma-ray peak with an energy corresponding to the energy of the radiation from transitions to one or more of the first four excited states of ^{40}Ca. The gamma rays from the individual excited state transitions were unresolved in this experiment. The area under the secondary peak is taken as the yield of gamma rays from the $^{39}K(p,\gamma_1 + p,\gamma_2 + p,\gamma_3 + p,\gamma_4)^{40}Ca$ reaction. The relative differential cross section for this reaction increases with energy by a factor of two over the range of excitation energies studied. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8492 PRESENT EXPERIMENTAL EVIDENCE ON WEAK MAGNETISM. V. L. Telegdi (Univ. of Chicago). p.26–37 of "Weak Interactions and Topics in Dispersion Physics." New York, W. A. Benjamin, Inc., 1963.

Experimental evidence that weak magnetism will produce effects in beta decay like first forbidden transitions and that these effects increase with increasing lepton moments is discussed. The effects in muon capture and neutrino reactions are also discussed. (L.B.S.)

8493 PHOTODISINTEGRATION OF He^3. J. R. Stewart, R. C. Morrision, and J. S. O'Connell (Yale Univ., New Haven). 35p. (CONF-481-82)

From American Physical Society Annual Meeting, New York, Jan. 1964.

The ^{3}He(γ,d)p differential cross section at 90° in the laboratory system was measured in the gamma energy range 8.5 to 46 Mev. A theory of Gunn and Irving (for a radius parameter $1/\mu = 2.7$ fermis) gives a good fit to the measured cross section. The ^{3}He(γ,2p)n proton spectrum produced by 40 Mev bremsstrahlung was also measured. This spectrum is found to disagree with predictions made by the theories of Gunn and Irving, and Delves. Comparison of the results with other experiments, including electron scattering, is made. A survey of sum rule predictions is included. (auth)

8494 WIDTHS AND LEVEL SHIFTS IN ^{16}O FROM THE UNIFIED SHELL MODEL. L. Garside. 7p. (CONF-452-39)

From American Physical Society, Washington, D. C., Apr. 1964.

The general expression for the transition matrix and an expression for the effective interaction are applied to the $^{16}O(\gamma,n)$ reaction. There are five particle-hole states giving rise to the giant dipole ^{16}O gamma cross section. The closed shell of 16 particles does not enter into the particle hole reaction and the shell or core potential well always corresponds to that of 16 nucleons. Results on widths are preliminary. (J.R.D.)

8495 CUMULATIVE YIELDS OF THE HEAVY FRAGMENTS IN THE THERMAL NEUTRON FISSION OF Pu^{241}. H. Farrar (Atomics International, Canoga Park, Calif.), W. B. Clarke, R. H. Tomlinson, and H. G. Thode. 34p. (CONF-649-12).

From 12th Annual Conference on Mass Spectroscopy and Applied Topics, Montreal, June 1964.

The relative yields of isotopes of xenon, cesium, barium, cerium, neodymium, and samarium formed by the thermal neutron fission of ^{241}Pu were obtained by mass spectrometric methods. The relative yields of the elements were normalized by means of the isotope dilution and isobaric techniques and absolute cumulative yields were determined by summing the relative yields to 100%. The curve obtained for ^{241}Pu is compared with other mass-yield curves. The general shape of this mass-yield curve is similar to that for ^{239}Pu, yet the fine structure shows greater similarity to that for ^{235}U thermal neutron fission. (auth)

Plasma Physics and Thermonuclear Processes

8496 (AD-606981) WAVEGUIDE ANALOGIES OF SCATTERING AND PROPAGATION IN INHOMOGENEOUS PLASMA. Lewis Wetzel and Leonard G. Cohen (Brown Univ., Providence). July 1964. Contracts Nonr(562)-35 and AF19(628)-2498. 32p. $2.00(OTS).

The conditions under which dominant mode propagation in a lossless tapered waveguide may serve as an analog of plane-wave propagation in a lossless inhomogeneous plasma are found. These conditions are relatively mild, thereby permitting a suitably tapered waveguide to be used as an analog computer for the determination of both field distributions and the reflection and transmission coefficients for plasma distributions having fairly arbitrary density profiles. The analogy is demonstrated by an experimental determination of the reflection coefficient for a linear plasma profile. Analogies based on the use of an inhomogeneous dielectric in a uniform waveguide are discussed briefly. It is found that such analogies are suitable for measurements only at a single frequency and are therefore of limited practical utility. (auth)

8497 (AED-C-12-07) NUCLEAR SCIENCE LITERATURE OF THE EASTERN BLOCK COUNTRIES. BIBLIOGRAPHIES. Plasmaphysics. Benno Ensslen and Rolf Paul, comps. (Kernforschungsanlage, Julich, Germany). Apr. 1964. 251p. Dep.(mn).

A bibliography is presented, consisting of 980 references to material on plasma physics. Author and report number indexes are provided. (T.F.H.)

8498 (CEA-R-2527) DEDUCTION D'UNE EQUATION CINETIQUE POUR DES PLASMAS STABLES OU FAIBLEMENT INSTABLES. 1ÈRE PARTIE. (Deduction of a Kinetic Equation for Stable or Slightly Unstable Plasmas. Part I). Simone Lafleur and Charles Lafleur (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Aug. 1964. 10p. (EUR-1832.f). Dep.(mn).

The kinetic equation for a homogeneous weakly unstable plasma, deduced using a very cumbersome method, can be very simply obtained from another formalism. (auth)

8499 (IPP-3/23) DRUCKERHÖHUNG IN DER ZYLINDERSYMMETRISCHEN LICHTBOGENSÄULE BEI UBERLAGERTEM AXIALEM MAGNETFELD. (Pressure Increase in a Cylindrically Symmetric Arc Column Located in an Axial Magnetic Field). S. Witkowski (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Oct. 1964. 20p. Dep.(mn).

Numerical calculations of pressure increases in the plasma of a cylindrical arc column are presented. Applicability of the corona equation is assumed. Results are given for external pressures of 10^{-1} to 2×10^5 dyne/cm^2 and temperatures up to 80,000°K. These results are compared with calculations using the Saha equation. (auth)

8500 (IPP/6/9) THE LASER AS A TOOL FOR PLASMA DIAGNOSTICS. Wilhelm H. Kegel (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Oct. 1963. 27p. (CONF-471-52). Dep.(mn).

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

The use of lasers for determination of local plasma parameters by analysis of the laser-light scattering, light-mixing and second-harmonic generation, the Faraday effect, interference effects, and shadowgraph techniques is described. The limitations of these methods are outlined. (T.F.H.)

8501 (IPP-6/11) THEORY OF THE RESONANCE PROBE. H. K. Wimmel (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Dec. 1963. 45p. Dep. (mn).

The theory of the resonance probe is critically reviewed and found unsatisfactory for three reasons. First, it neglects the resonance increase of the r-f field produced by the plasma-sheath inhomogeneity. Second, it uses an improper normalization of the r-f field amplitude. Third, it yields a resonance frequency which, for given electron density, is independent of the sheath thickness, in contradiction to experiments. The d-c electron current as a function of frequency is computed for two different one-dimensional models of the resonance probe that take the r-f resonance mentioned above into account. The r-f field is derived from linearized plasma equations. The plasma equations neglect Landau damping, but contain a "collision frequency" that must be of the order of the plasma frequency in order to obtain reasonable results. The d-c current is derived by summing over all electrons having positive kinetic energy at the probe surface. Here, collisions are neglected, and the time of flight is estimated from the unperturbed electron velocities. Both models yield a d-c resonance. There is no resonance at the plasma frequency at all. These results are in qualitative agreement with experiments. (auth)

8502 (IPP-6/17) ON THE INFLUENCE OF A TENSOR FRICTION UPON DIFFUSION IN A MAGNETIC FIELD. B. N. A. Lamborn (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). May 1964. 48p. Dep.(mn).

The Langevin equation for a charged particle moving in a plasma with a constant magnetic field is integrated under the assumption that the friction tensor may be a slowly varying function of time. The average particle energy along and perpendicular to the field is given. It reduces to the equilibrium value as $t \to \infty$. The diffusion coefficients are calculated for some typical forms of the friction tensor. The magnetic field tends in general to stabilize the plasma by reducing the effects of an anisotropic friction tensor, when the dependence of the friction term itself on the field strength is ignored. If none of the principal axes of the friction tensor are parallel to the field direction, then the motion along the magnetic field may also be a function of the field strength. The velocity diffusion coefficients due to binary collisions are discussed and integrated analytically for a Maxwellian distribution of the field particles. The spatial integration is performed to a maximum distance of closest approach rather than to a maximum impact parameter. The result may be expressed as a function of the ratio of the distance of closest approach for head-on, two-body collisions to the Debye shielding distance and is correct for all velocities of the incident particle. (auth)

8503 (IPP-6/28) RADIAL DISTRIBUTION FUNCTIONS IN A TWO-COMPONENT PLASMA. P. P. J. M. Schram and W. H. Kegel (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Oct. 1964. 27p. Dep. (mn).

General expressions for the radial distribution functions in an electron-ion-plasma outside thermal equilibrium are obtained from the hierarchy equations in first order of the plasma parameter. It is shown that these expressions can also be derived in the framework of the test particle problem. In the special case of Maxwellian distributions with different temperatures for electrons and ions, and under the mild restriction that the thermal velocity of the ions is much smaller than that of the electrons the results reduce to familiar expressions. A phenomenon, which may be called "antishielding," is shown to follow from the electron-electron radial distribution function in the case that the electron temperature is smaller than the ion temperature. The influence of a magnetic field is shown to vanish in the special case of two Maxwellians. (auth)

8504 (SC-RR-64-988) ASSEMBLY OF AN ARGON PLASMA IN MAGNETIC MIRROR GEOMETRY. John R. Banister, Everet H. Beckner, and Richard D. Jones (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract [AT-(29-1)-789]. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The production of an argon plasma in a magnetic mirror geometry, generated by twin electrodeless ring discharges, has been examined by using a high-speed framing camera and by extensive magnetic probing. The survey was carried out over a density range sufficient to permit observation of a wide variety of phenomena, from a totally ballistic assembly at 3 torr initial pressure to an assembly dominated by magnetic forces at the lowest density (0.03 torr initial pressure). It was found that the early assembly could be described by a snow-plow model at the lower initial pressures (0.03 and 0.3 torr). Substantial magnetic field compression was observed at these lower initial densities with the development of magnetic tension effects. This field compression was also accompanied by the appearance of an early luminosity in the case of the lowest initial density. This luminosity indicates breakdown of the ambient gas, which occurs when photoelectrons are accelerated by the azimuthal electric field. The magnetic probing revealed evidence of a tensor electrical conductivity in the plasma generated at the lowest initial pressure. (auth)

8505 (SC-RR-64-1273) COAXIAL RAIL ACCELERATION OF METAL-DERIVED PLASMAS (PHASE II). Ralph L. Schellenbaum (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract [AT(29-1)-789]. 69p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Investigations have been performed in the operation of an electrical discharge, coaxial rail plasma accelerator of the Marshall type for the production of high velocity, density, and mass number plasmoids. Experimental observations of an exploding bridgewire injection method are described. Plasma diagnostic instrumentation includes optical spectroscopy, time-resolved photography, Faraday ion probes, and electrostatic ion analysis. Velocity and energy distributions are presented for plasmoids generated with Au injection. Diagnosis of distribution peaks indicate plasma velocity of 9×10^6 cm/sec (1.6×10^7 cm/sec max), an average particle density of 2.8×10^{11} cm^{-3}, and 8 kev energy (26 kev max) at a distance of 353 cm from the gun muzzle with no external magnetic field confinement. H_2^+ ions are observed at a velocity of 5.6×10^7 cm/sec. Hydrogen, carbon, and oxygen are identified as major contaminants. Special considerations are: the nature of the accelerator gun operation and resulting plasmoid characteristics, reduction of contaminants, and attainment of higher energy plasmoids. (auth)

8506 (SC-TM-64-64A) INTERACTION OF PLANE ELECTROMAGNETIC WAVES WITH A FULLY IONIZED

PLASMA. A. J. Russo (Sandia Lab., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 24p. Dep. (mn); $1.00(cy), 1(mn) OTS.

Classical formulas for the interaction of high-frequency electromagnetic radiation with a fully ionized, nonrelativistic plasma are presented. The development uses a plasma model in which the ions are considered immobile and the electron velocity distribution is approximately spherically symmetric. Graphical data for the transmission and attenuation of one optical frequency as a function of temperature and density are given. (auth)

8507 (UCRL-Trans-1131(L)) STUDY OF THE STABILITY OF PLASMA IN THE PR-5 APPARATUS. Yu. V. Gott, M. S. Ioffe, M. V. Nezlin, and R. I. Sobolev (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii. Institut Atomnoi Energii Im. I. V. Kurchatova, Moscow). Translated for Univ. of California Lawrence Radiation Lab., Livermore, from report IAE-658, 1964. 42p. Dep.(mn); $2.00(cy) 1(mn) OTS; $4.60(fs), $1.46(mn)JCL.

The confining properties of an adiabatic magnetic trap, with the field increasing both in the longitudinal and in the radial directions, are studied. A field of this kind can be obtained by combining the solenoid field and a field due to a system of current-carrying conductors, the conductors being parallel to the axis of the trap (stabilizing field $H_\perp$). The conductors are disposed uniformly in the azimuth around the side wall. Two independent methods were used to fill the trap with plasma: the ion magnetron method, and the method involving the accumulation of plasma from an unstable plasma beam. In experiments with magnetron-type injection the density of plasma in the trap was 10^9 to 10^{10} cm^{-3}, the mean proton energy was ≈5 kev (mean deuteron energy being approximately equal to 8 kev), and the electron temperature was ≈20 ev. The plasma lifetime was measured as a function of $H_\perp$ and of the pressure of the neutral gas. The experimental results show that a composite field of this kind ensures stable confinement of plasma independent of magnetohydrodynamic instability [at least for $\beta \sim 10^{-4}$]. The stabilization is confirmed by an analysis of plasma oscillations at different values of $H_\perp$. The decay of the plasma is determined by charge transfer between fast ions and the residual gas. Maximum confinement times were 0.06 sec at a pressure of 7×10^{-9} mm Hg. Qualitative information about the distribution of plasma density along the radius of the trap was obtained. In experiments in which the trap was filled by an unstable beam, the plasma density was (2 to 3) $\times 10^{11}$ cm^{-3}, the proton energy was ≈1 kev, and the electron energy was ≈50 ev. Under these conditions, the plasma lifetime in the trap was found to be 10 to 100 msec, and was again determined by charge transfer between protons and the residual gas. (auth)

8508 VORTEX GAS ACCELERATOR. Stirling A. Colgate (Univ. of California, Livermore). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2138-42(Dec. 1964). (UCRL-7377)

The exhaust velocity of a propellant gas from an isothermal cavity can be significantly increased by a factor of approximately 1.7 above that corresponding to the usual isentropic expansion by utilizing multiple reheat by blackbody radiation from the walls during expansion. In order to reduce the necessary volume and the frictional drag with the walls during this reheat and expansion process, the gas is wrapped up in a rotational flow pattern in which angular momentum per unit mass is constant along all streamlines. As a consequence, the expansion in the nozzle corresponds to the conversion of rotational to linear momentum, rather than the usual thermal to linear. In order to absorb the radiant energy from the walls, the gas must have a sufficient optical opacity (achieved by a small contaminant addition to hydrogen) such that the gas in the cavity is approximately one radiation mean free path thick. (auth)

8509 PRINCIPLE CHARACTERISTICS OF THE EXPERIMENTAL THERMONUCLEAR INSTALLATION "TOKAMAK-3." M. A. Gashev, G. K. Gustov, K. K. D'yachenko, et al. At. Energ. (USSR), 17: 287-94(Oct. 1964). (In Russian)

A description is given of Tokamak-3, intended for the study of a toroidal quasistatic discharge in a strong longitudinal magnetic field. Basic parameters of the magnetic field systems, the supply system, and the vacuum system and some construction data and diagrams are presented. (tr-auth)

8510 EQUILIBRIUM SHOCK-WAVE CALCULATIONS IN INERT GAS, MULTIPLY IONIZED DEBYE-HUCKEL PLASMAS. M. McChesney (Univ. of Liverpool). Can. J. Phys., 42: 2473-94(Dec. 1964).

The physical basis of existing equilibrium inert-gas shock-wave calculations is reviewed, and their limitations are outlined. The various solutions to the problems of terminating the electronic excitation partition function and also the lowering of the ionization potentials by a plasma microfield are discussed and coordinated into a family of cutoff procedures. New equilibrium shock-wave equations are derived which allow for multiple excitation and ionization and the presence of Debye-Huckel effects in the shock-heated plasma. It is demonstrated how the use of such a plasma model logically and simply provides a solution to the problem of energy-level cutoff. (auth)

8511 PLASMA CONFINEMENT DEVICE WITH A REVERSED FIELD. [PART] II. Masaru Sugiura, Kohei Ogasawara, Masayuki Iguchi, Isao Hirota, Kiyoo Tanaka, and Shuichiro Kawamata. Denki Shikensho Iho, 28: 340-6(1964). (In Japanese)

Results are given of measurements that were carried out to clarify the characteristics of a plasma confinement device with a reversed field. These include: measurements of magnetic fields induced inside the torus tube by a primary coil current and a revision of the fields; measurements of magnetic fields induced inside the torus tube by a transposed primary coil current and a revision of the fields; measurements of one turn loop voltage induced inside the torus tube by a primary coil current; and measurements of magnetic fields induced on the axis of the major diameter of torus by a primary coil current. The primary circuit of the device with the above-mentioned revision is given. (auth)

8512 ON THE HIGH-FREQUENCY WAVES IN PLASMA DRIFTING IN A MAGNETIC FIELD. G. Kh. Kamenetskaya and M. S. Kovner (Gor'kii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 596-604(1964). (In Russian)

Wave propagation in a drifting magnetoactive plasma is considered in a quasi-hydrodynamic approximation. The number of normal waves turns out to be 8 in this case. The dispersion equations are investigated, and the results obtained are discussed. (auth)

8513 CONCERNING THE TENSOR OF THE EFFECTIVE DIELECTRIC PERMEABILITY OF NONHOMOGENEOUS MAGNETOACTIVE PLASMA. Yu. A. Ryzhov and V. V. Tamoikin (Gor'kii State Univ., USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 605-10(1964). (In Russian)

An expression was obtained for the effective-permeability tensor of a weakly nonhomogeneous magnetoactive plasma. A specific calculation was carried out for the case when the dimensions of the homogeneities are small as compared to the wavelength. (auth)

8514 ON THE POTENTIAL OSCILLATIONS OF STRONGLY NONHOMOGENEOUS RAREFIED PLASMA. V. V. Arsenin (Inst. of Engineering Physics, Moscow). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 611-17 (1964). (In Russian)

Using the dielectric-permeability tensor of a rarefied plasma with an arbitrary nonhomogeneous structure, the equation for the potential oscillations was obtained. The short wave perturbations of the rarefied plasma are shown to be potential. Oscillations of a strongly nonhomogeneous plasma with frequencies equal to the ion gyrofrequency are considered. (auth)

8515 KINETIC THEORY OF PLASMA WAVEGUIDE IN A STRONG MAGNETIC FIELD. A. N. Kondratenko. Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 652-6(1964). (In Russian)

The propagation of electromagnetic oscillations in a cylindrical plasma waveguide bordering on vacuum and in a strong magnetic field is considered on the basis of the kinetic equation with a self-consistent field, neglecting close collisions of particles. Cases of isothermal and nonisothermal plasma are studied. Values of the phase velocity and attenuation factors are found as functions of the waveguide radius, temperature of plasma particles, and frequency of the propagating wave. (auth)

8516 ON THE TRANSIENT RADIATION IN MAGNETOACTIVE PLASMA. V. M. Yakovenko (Inst. of Radiophysics and Electronics, Academy of Sciences, USSR). Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 7: 657-63(1964). (In Russian)

The transient radiation problem in a magnetoactive plasma is solved by the kinetic equation method. An expression is found for the spectral density of radiation in vacuum under the condition of electron mirror reflection from the plasma surface. Peculiarities of transient radiation in a magnetoactive plasma are discussed. (auth)

8517 HIGH-FIELD MAGNETORESISTANCE OF INHOMOGENEOUS SEMICONDUCTORS AND PLASMAS. II. TWO-DIMENSIONAL INHOMOGENEITY DISTRIBUTIONS. J. A. Morrison and H. L. Frisch (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Math. Phys. (N. Y.), 5: 1672-81(Dec. 1964).

The treatment of the high field magnetoresistance of a previously described classical model of a semiconductor (plasma) containing a two-dimensional distribution of inhomogeneities is extended. The basic assumptions on the classical model are that the scale of the inhomogeneities is large compared to the mean thermal wavelength of an electron and the Landau level spacing is large compared to kT. The magnetic field $\mathcal{H}$ is taken parallel to the z coordinate and the inhomogeneity distribution is characterized by a sufficiently smooth potential $\varphi(x,z)$. The 4-moment equations are solved asymptotically for large $\mathcal{H}$, and an equivalent asymptotic solution is obtained, subject to certain mathematical assumptions, for the transport equation. The magnetoresistance is shown, in general, not to saturate, but to increase, as $\mathcal{H}^2$, with increasing $\mathcal{H}$. (auth)

8518 HIGH-FIELD MAGNETORESISTANCE OF INHOMOGENEOUS SEMICONDUCTORS AND PLASMAS. III. TWO-DIMENSIONAL INHOMOGENEITY DISTRIBUTIONS. J. A. Morrison and H. L. Frisch (Bell Telephone Labs , Inc., Murray Hill, N. J.). J. Math. Phys. (N. Y.), 5: 1681-7(Dec. 1964).

Computations of the leading terms of the components of the resistivity tensor to the two-dimensional case in which the external magnetic field $\mathcal{H}$ is inclined (but not perpendicular) to the plane of variation of the spatial inhomogeneity distribution are extended. The field $\mathcal{H}$ is applied along the z axis, and the inhomogeneity distribution is characterized by a sufficiently smooth potential $\varphi(x,z+\lambda y)$. While the magnetoresistance ratios saturate in the y and z directions, it is found that this ratio is proportional to $\mathcal{H}^2$ (as $\mathcal{H} \to \infty$) in the x direction. (auth)

8519 USEFUL OPERATOR IN PLASMA KINETIC THEORY. Ching-Sheng Wu (California Inst. of Tech., Pasadena). J. Math. Phys. (N. Y.), 5: 1701-12(Dec. 1964).

An operator which facilitates the derivation of the plasma kinetic equation is introduced and discussed. The operator determines the first integral of the pair correlation function without the necessity for knowledge of the pair correlation function itself. To break through the lengthy algebraic effort which is usually encountered in solving the truncated BBGKY hierarchy equations, the present operator method is found to be far superior to the singular integral equation technique. The mathematical simplification which can be gained from the use of this operator is demonstrated by several examples. (auth)

8520 AN ELECTROSTATIC ION-ENERGY ANALYSER. D. W. Mason (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 6: 553-8 (Nov.-Dec. 1964).

An ion-energy analyzer was developed in order to measure the performance of a coaxial plasma gun. The analyzer was also slightly modified to observe the small flux of ions produced when neutral atoms, originating from charge exchange in a partially ionized plasma, are reionized in a water-vapor cell. The analyzers may be used in the presence of an axial magnetic field and operate up to at least 30 kev ion energy with an energy resolution that may be varied by suitable biases from a few percent upwards. (C.E.S.)

8521 DRIFT OF A PLASMA IN A CURVED MAGNETIC FIELD. P. C. T. van der Laan (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). J. Nucl. Energy, Pt. C, 6: 559-66(Nov.-Dec. 1964).

A plasma confined by an externally applied curved magnetic field will show an accelerated motion (drift) to the region of weaker field. This motion is analyzed in three different ways. In the first description the magnetohydrodynamic equation of motion is used, with the only assumption that no appreciable transverse accelerations are present. Secondly, the well-known microscopic picture (charge separation leading to E/B drift) is analyzed for a $\beta \ll 1$ plasma with the guiding center approximation. In the third model the change in the total energy of the system caused by a small outward displacement is considered. In all models the outward acceleration is found to be $a_R = 2k(T_i + ZT_e)/Rm_i$ where R is the radius of curvature of the field. The energy for the outward motion is partly supplied by the primary circuit and partly by an expansion of the plasma. (auth)

8522 HIGH-FREQUENCY HEATING OF ELECTRONS IN A MIRROR MACHINE. M. Seidl (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 6: 597-616(Nov.-Dec. 1964).

The motion of electrons contained in a mirror field with a superimposed r-f field is analyzed using a perturbation treatment. The unperturbed motion (with no r-f field present) is expressed as a multiperiodic system whose hamiltonian is calculated as a function of the three adiabatic invariants. The r-f field is considered as a perturbation. It is shown that the r-f field (with electric field perpendicular to the mirror field) affects only the perpendicular invariant (which is proportional to the magnetic moment). Appreciable changes of the perpendicular invariant occur only to electrons having a certain amplitude of longitudinal oscillation determined by the applied frequency. When the electrons have such a small amplitude of longitudinal oscillation that they stay in a practically uniform field, the r-f field causes a rapid increase of the magnetic moment. In all the other cases, however, the effect of the r-f field is only a small periodic fluctuation of the magnetic moment. The mechanism of r-f heating in a mirror field is discussed. It is shown that the heating is a slow statistical process which is made possible by electron collisions or some equivalent randomizing process. (auth)

8523 MICROWAVE PROPAGATION IN A PLASMA WITH A SHEARED MAGNETIC FIELD. M. A. Heald (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 6: 617-29(Nov.-Dec. 1964). (CLM-P-42)

The propagation of a plane electromagnetic wave through a Lorentz plasma in a sheared magnetic field is considered. The characteristic waves in a uniformly sheared, but otherwise homogeneous, medium are found, and their properties presented graphically. Some effects introduced by the presence of shear are investigated by means of elementary applications of the uniform-shear theory. By suggested extensions of the analysis, refinements may be made in the interpretation of microwave diagnostic experiments with controlled-fusion containment devices having complicated sheared fields. (auth)

8524 INFLUENCE OF A WEAK MAGNETIC FIELD ON THE COLLISION DAMPING OF WAVES IN THE PLASMA. Utaro Furukane (Hiroshima Univ.). J. Sci. Hiroshima Univ. Ser. A-II, 28: 1-17(June 1964).

The coefficients of collision damping of waves in the plasma, in a constant, uniform weak magnetic field, are

calculated by means of the Fokker-Planck collision terms up to the second order in the magnetic field strength and to the first order in the collision frequency. It is found that the damping of the waves belonging to the left cutoff increases with an increase in magnetic field and the damping of the waves belonging to the right cutoff and the plasma cutoff decreases in the case where the mean thermal speed of electrons is comparatively small compared with the wave phase velocity. The Landau damping coefficient is also calculated. (auth)

8525 SPECTROSCOPIC STUDIES OF SHOCK HEATED PLASMAS PRODUCED BY ELECTROMAGNETIC T-TUBES. Toshiatsu Oda (Hiroshima Univ.). J. Sci. Hiroshima Univ. Ser. A-II, 28: 57-70(June 1964).

The time-resolved spectra of Si II, Si I, and H indicate that the contamination of the plasma by silicon atoms set free from the tube wall is retarded by 2 μsec after the passage of the shock front. The experimental conditions are as follows: the discharge voltage is 25 kv and the initial pressure of hydrogen is 1 mm Hg. The retardation time increases with the decrease of the discharge voltage. The electron number density N_e is also determined spectroscopically based on the line broadening. For hydrogen, with a shock speed of 3.0 cm/μsec (initial pressure 1 mm Hg) the measured line broadening indicates $N_e = 1.0 \times 10^{17}$ cm^{-3}, which is much higher than the shock theory value (0.43×10^{17} cm^{-3}). The influence of a transverse magnetic field on the spectra of shock-heated plasma flow is also studied. (auth)

8526 DETECTION OF THE ONSET OF INSTABILITY IN A CYLINDRICAL MAGNETOHYDRODYNAMIC FLOW. J. A. Baylis (Cambridge Univ., Eng.). Nature, 204: 563 (Nov. 7, 1964).

Stability of the circular magnetohydrodynamic flow between stationary cylinders of a conducting liquid, which is driven by the interaction of an axial magnetic field with radial currents, was studied. Small perturbation analysis gave equations identical to those for pressure-driven circular flow with an axial magnetic field. Experimental values were obtained with cylinders of high-conductivity copper and mercury as the liquid. (M.C.G.)

8527 EFFECTS OF COLLECTIVE BEHAVIOR ON THERMAL RADIATION SPECTRUM. Shinzo Nakai (Duke Univ., Durham, N. C.). Nucl. Phys., 63: 131-44(Mar. 1965).

The e^3-order corrections to the thermodynamic properties of a gas of electrons and photons was considered using the methods of relativistic quantum field theory. Modifications of the thermal radiation spectrum due to the collective behavior of electrons in a fully ionized gas were examined. The mechanisms by which the electromagnetic field can be coupled to a plasmon were analyzed in detail. The modified Planck distribution predicts a decrease in the expected number of photons with momenta $\omega_p^2/2c^2k^2 \geq 1$, where ω_p is the plasma frequency. (auth)

8528 NATURE OF THE JOULE-THOMSON PHENOMENON IN PLASMAS. L. Gold (Martin Co., Baltimore). Nuovo Cimento (10), 34: 1371-80(Dec. 1, 1964).

The nonideality of an ionized gas is associated with the Coulomb energy, which attains a maximum at some intermediate temperature, as is readily demonstrated for a thermally ionized gas using the Saha equation. Such imperfect gases may on free expansion be accompanied by reduction of temperature far greater than the analogous response of a neutral gas, where much weaker van der Waals forces are at work. Within the limitations of approximate equations of state for ionized gases, the Joule-Thomson (J.T.) phenomenon is characterized. The Debye length proves to be a key parameter in the behavior of the J.T. coefficient. Adiabatic heating and coolant action are discussed. The role of the J.T. phenomenon in MHD devices, re-entry physics, refrigerant action in sunspots, and high-temperature production is briefly considered. (auth)

8529 FLUCTUATIONS OF ELECTRODELESS RING DISCHARGES IN STATIC MAGNETIC FIELDS. C. J. Ransom and H. Schlueter (Univ. of Texas, Austin). Phys. Letters, 13: 313-14(Dec. 15, 1964).

The transport of plasma particles across a magnetic field in a powerful electrodeless r-f ring discharge without the presence of a d-c discharge current was investigated. The enhanced losses and fluctuating behavior were discussed. (C.E.S.)

8530 ELECTRON WAKES IN A PLASMA. P. J. Barrett (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). Phys. Rev. Letters, 13: 742-3(Dec. 21, 1964).

Measurements were made with a Langmuir probe of the floating potential and plasma potential near a quartz obstacle placed in the positive column of a low-pressure mercury-arc discharge in a longitudinal magnetic field. Since electrons spiraled past the obstacle in both axial directions, a wake was produced on either side of the obstacle extending over a distance several times greater than the obstacle diameter. The inner region of the wake on the anode side appeared as a dark shadow and that on the cathode side appeared bright. (C.E.S.)

8531 NONLINEAR EFFECTS IN THE REFLECTION AND REFRACTION ON A COLD MAGNETOPLASMA. F. W. Sluijter (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica, 30: 1817-32(Oct. 1964).

Starting from the nonlinear cold-plasma equations expressions are derived for the first order corrections to the linearized solutions for a plane linearly polarized monochromatic electromagnetic wave propagating in the plasma perpendicular to a static magnetic field. Two significant directions, the ordinary and extraordinary wavemode, are treated. The results are used to find the first order corrections to the reflected and refracted wave caused by a plane wave incident from vacuum on a plane boundary of a homogeneous semi-infinite plasma with a static magnetic field perpendicular to the plane of incidence. These corrections consist of plane waves at the double frequency, polarized in the plane of incidence for both directions of the polarization of the incident wave: one wave propagating in the same direction as the reflected fundamental-frequency wave, one in the same direction as the refracted wave and with the same phase velocity and one transmitted in the plasma in a direction and with a phase velocity in agreement with the refractive index at the double frequency. The validity of the theory is examined for index matching. In the case of the incident wave polarized in the plane of incidence the results are examined for the fundamental frequency equal to the plasma frequency. (auth)

8532 GRAZING INCIDENCE SPECTRA OF HIGHLY IONIZED OXYGEN IN A THETA PINCH. N. J. Peacock (Atomic Energy Research Establishment, Abingdon, Berks, Eng.). Proc. Phys. Soc. (London), 84: 803-5(Nov. 1964). (CLM-P-48)

A thetatron discharge is shown to be a particularly rich source of highly ionized oxygen lines. The identification of transitions in O(VI) and O(VII) which decay to the n = 2 principal quantum level was extended using this source and a diffraction grating at grazing incidence. (auth)

8533 EFFECTS OF GRAVITATIONAL FORCE ON COLLECTIVE MOTIONS IN PLASMA. Mario Yokota (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 32: 478-8(Oct. 1964).

The coupled equations of the mass density wave and the magnetohydrodynamic wave under the gravitational force are obtained by using the hamiltonian formalism of the total system and Tomonaga's method of collective variable. The conditions of strong coupling between the waves are discussed. (auth)

8534 THE EFFECT OF FINITE ION LARMOR RADIUS ON THE ALFVEN WAVE INSTABILITY. Nobuo Yajima and Tosiya Taniuti (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 32: 671-3(Oct. 1964).

The effect of finite ion Larmor radius on the Alfvén wave instability in plasma is discussed, and it is shown that the Alfvén mode is stabilized by the finiteness of the Larmor radius. (C.E.S.)

8535 DETERMINATION OF ELECTRON CONCENTRATION IN VARIOUS TYPES OF ARC PLASMA. V. M. Goldfarb and E. V. Ilina. Sb. Tr. Leningr. Mekhan. Inst., No. 33, 142-9(1963).

When easily ionizable atoms of metals are introduced into a plasma, a change is observed in the electron concentration n_e and in the temperature T of the plasma. Calculation is made extremely difficult by the necessity for taking into account a multiplicity of factors in these processes. The concentration of electrons in the plasma atmospheric pressure was determined with the use of one of the well known optical methods on the relative intensities of lines of atoms and ions. A mercury rectifier served as the power supply for the arc and an h-f generator was used for ignition. The current used in the experiments was 8 amps at 300 volts; the distance between electrodes was 6 mm; the diameter of the electrodes was 6 mm. A KS-55 spectrograph was used to photograph the spectrum, and measurement was made of the relative intensities of lines Zn 13072.06 and Zn 13075.90, Ca 14226.73 and Ca 113968.47 Å. It is established that there is a drop in the temperature of the plasma with a decrease in the ionization potential and an increase in the metal concentration. The results of measurements are evaluated. A mathematical calculation of the n_e concentration indicates that in spite of the reduction in temperature, the introduction of metals leads to an increase in n_e. It is noted that the determination of n_e by the given method is not accurate since an error of 100–200°C in determination of T leads to an error on the order of 50–100% in n_e. It is proposed that an increase in n_e by a single order for high concentrations of slightly ionized atoms goes beyond the limits of possible error. Reasons are given for the possibility of an increase in n_e when metals are introduced into the arc. There is a graphical demonstration of the relation between the electron concentration, plasma temperature, discharge radius, arc voltage, and concentration of sodium atoms. (OTS)

8536 THE PLASMA STATE. THE PRODUCTION OF PLASMA AND USES IN CHEMISTRY AND METALLURGY. Jon A. Bakken and Johan K. Tuset. Tidsskr. Kjemi, Bergvesen Met., 24: 178-87(Oct. 1964). (In Norwegian)

Some properties of the plasma state discussed. A survey was made of the history of plasma generating devices. Methods of producing thermal plasmas for technical, chemical, and metallurgical applications are described. The research field of plasma chemistry is reviewed with emphasis on potentialities of plasma processing in industry. (auth)

8537 QUANTUM CORRELATION FUNCTIONS IN MAXWELL'S PLASMA. B. A. Trubnikov and V. F. Elesin. Zh. Eksperim. i Teor. Fiz., 47: 1278-90(Oct. 1964). (In Russian)

Quantum effects are considered for the probabilities of relative positions of two particles in completely ionized Boltzmann plasma. These probabilities make it possible to obtain simply the thermodynamic potential of such a plasma; this potential has been previously calculated using the diagram technique by Vedenov and Larkin. Also, the momentum- and coordinate-dependent quantum two-particle distribution functions are obtained in the explicit form for the case of the equilibrium plasma; these functions are the immediate quantum analog of the corresponding classic functions. (auth)

8538 KINETIC THEORY OF THE PROPAGATION OF STRONG ELECTROMAGNETIC WAVES IN SEMICONDUCTORS OR A PLASMA. F. G. Bass (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1322-41(Oct. 1964). (In Russian)

The effect of heating of electrons in a plasma or in semiconductors by an electromagnetic field and of the nonlinearity resulting from this circumstance on propagation of the field is investigated. The character of decay of the field in a medium is studied in the nonresonance case when nonlinearity of the Maxwell equations is small and also in the case of magnetoplasma and cyclotron resonances when the nonlinearity is strong. The dependence of the surface impedance on the amplitude and frequency of the incident electromagnetic field and on an external stationary magnetic field is determined. (auth)

8539 QUASILINEAR THEORY OF THE OSCILLATIONS, EXCITED BY AN ELECTRON BEAM INJECTED IN A SEMIINFINITE PLASMA. Ya. B. Fainberg and V. D. Shapiro (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 47: 1389-1404(Oct. 1964). (In Russian)

Space distribution of the oscillations excited by an electron beam injected into a semiinfinite plasma with the directed velocity much larger than the thermal velocity of plasma electrons is considered. It is shown that in this case the energy lost by the beam on the excitation of the oscillations accumulates in a rather narrow transitional layer on plasma boundary in which relaxation of the beam occurs. In this layer the oscillation energy density can greatly exceed the beam energy density. (auth)

8540 ON NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN A PLASMA. L. M. Gorbunov, V. V. Pustovalov, and V. P. Silin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1437-53(Oct. 1964). (In Russian)

Nonlinear interaction of long transverse waves with transverse or longitudinal waves is considered by means of the nonlinear equation for evolution of field fluctuations in a plasma. The effect of a transverse field on nonlinear relaxation of longitudinal waves is elicited. (auth)

8541 EFFECTS OF TRANSVERSE ELECTROMAGNETIC WAVE DECAY IN A PLASMA. L. M. Kovrizhnikh and V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1454-62(Oct. 1964). (In Russian)

Equations are derived which describe three-plasma induced scattering and transverse wave decay in a plasma. Transformation of intense transverse waves into longitudinal plasma waves with nonrelativistic or relativistic phase velocities is considered. The change of the transverse wave spectrum during transversal through a turbulent plasma is discussed. (auth)

8542 RADIATION EMITTED BY CHARGED PARTICLES SCATTERED ON ELECTROMAGNETIC WAVES IN AN ISOTROPIC PLASMA. A. Gailitis and V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 47: 1468-82(Oct. 1964). (In Russian)

The cross section for scattering of longitudinal waves on an arbitrary charge moving in a plasma is calculated by taking into account nonlinearity of the plasma. Variation of the cross section for emission of Cherenkov radiation of longitudinal waves by a charged particle due to nonlinear effects is considered. The results are valid for arbitrary particle velocities and wave phase velocities. The cross sections can thus be employed for deriving the kinetic equations describing nonlinear effects in plasmas of arbitrary temperatures, including ultrarelativistic effects. The nonlinear equations take into account effects of longitudinal wave interaction as well as effects of nonlinear interaction of transverse and longitudinal waves. The results obtained are applied for estimating the role of nonlinear effects involved in acceleration of cosmic rays by plasma waves. (auth)

8543 THE KINETICS OF WAVES IN A WEAKLY TURBULENT PLASMA. L. M. Altshul and V. I. Karpman (Novosibirsk State Univ., Siberia). Zh. Eksperim. i Teor. Fiz., 47: 1552-74(Oct. 1964). (In Russian)

A kinetic equation for waves in a weakly turbulent plasma is derived in a form which yields simple symmetry relations for various terms of the equation. Some consequences of these relations are discussed. It is shown, in particular, that in a number of cases the number of waves (quasiparticles) is conserved during non-decay interaction. (auth)

8544 DETERMINATION OF THE ELECTRON DENSITY IN A NITROGEN PLASMA. F. Doebler. Thesis, Brunswick, Technische Hochschule, 1964. 77p. $2.00 (AED-DISS. 64-49). (In German)

The design and construction of a microwave bridge apparatus with an open transmission line for the measurement of electron density in a decaying plasma is described. Bridge unbalance is recorded continuously by an oscilloscope so that the time dependence of electron density can be analyzed directly. Nonlinearity is smaller than 0.43% for a phase shift smaller than 0.05π. The design of a high frequency power generator for the production of a homogeneous plasma is also described. The volume recombination coefficient depends more strongly on temperature as was thought before. This fact can be of importance for ionosphere studies because of the high temperatures in high altitudes. (Gmelin Inst.)

8545 OHMIC HEATING OF A H PLASMA. H. Schrade. Thesis, Stuttgart, Technische Hochschule, 1963. 53p. $2.00(Gemlin, AED-DISS, 63-613). (In German)

Using the Boltzmann equation theoretical expressions for the conservation of density, mean velocity, pressure tensor elements, and heat current vector of a nonreacting plasma are given. Motion and thermal behavior of each single gas were treated separately. Based on a channel model the time dependence of high current pulse discharges in H of 1 and 10 atm were calculated. Stability of the discharge channel was studied. An estimation of the energy available for heating is given. (Gmelin Inst.)

8546 ELECTROSTATIC OSCILLATIONS IN COLD INHOMOGENEOUS PLASMAS. Eugene Myron Barston. Thesis, Stanford, Calif., Stanford Univ., 1964. 168p.

A theoretical investigation of small-amplitude electrostatic oscillations in cold inhomogeneous plasmas and beam-plasma systems is presented. It is demonstrated that for those systems possessing continuous nonconstant unperturbed electron-ion densities, a Fourier or normal-mode analysis in time leads in general to singular modes and a continuous frequency spectrum. While any finite sum of such singular modes is not an acceptable solution to the small-amplitude theory, well-behaved solutions to the linearized partial differential equations describing the system are obtained by taking a Fourier integral superposition (inverse Fourier transform) of the singular modes over their continuous spectrum. Explicit solutions are obtained for certain plasmas with plane, cylindrical, and spherical symmetry. The inhomogeneous beam-plasma systems investigated are of two types: (1) the transversely inhomogeneous system, where the beam and plasma are assumed uniform along the beam axis and nonuniform in the orthogonal plane; (2) the longitudinally inhomogeneous system, where the beam is assumed everywhere uniform and the plasma is nonuniform along the beam axis. The instabilities of the infinite homogeneous beam-plasma system are found to be present in the continuous transversely inhomogeneous system. The treatment of the longitudinal inhomogeneity is devoted to demonstrating the existence of amplification in such a system for beam modulation frequencies near to but greater than the maximum value of the plasma frequency. A variational technique for computing the discrete part of the frequency spectrum is presented. Its attractiveness lies in the fact that it is formulated in a sufficiently general manner so as to be applicable to relativistic as well as to nonrelativistic multi-stream problems. (A.G.W.)

8547 SOME HIGH FREQUENCY TECHNIQUES FOR THE ANALYSIS OF A GASEOUS DISCHARGE PLASMA. Robert Morris Montgomery. Thesis, Lafayette, Ind., Purdue Univ., 1963. 91p.

The fluid dynamic equations are used to solve for the high frequency impedance between electrodes in a partially ionized plasma. For the time-independent case the momentum and continuity equations are solved with Poisson's equation to obtain the potential distribution and electron density in the region near a negatively biased planar electrode. The solutions are then used with a perturbation technique to solve for the high-frequency electric field in the sheath and in the plasma. It is shown that for sufficiently low frequency, the total impedance "seen" by an electrode inserted in the plasma is due to the sheath capacitance. This capacitance is calculated as a function of the d-c bias on a cylindrical electrode whose radius is large compared to the Debye length. Experimental data are shown to verify the calculated results. For higher frequencies the theory shows that there is a series resonance at that frequency where the capacitive sheath reactance is equal to the inductive reactance of the bulk of the plasma. The minimum of impedance at this resonance is shown to depend upon the electron collision frequency. All the results mentioned were calculated for short coaxial cylinders with plasma between them, and an experimental discharge tube of this geometry was constructed. The impedance between the cylinders was measured over a frequency range from 50 to 500 Mc, and the shape of the impedance vs. frequency curve is identical to that predicted by the theory. Values of plasma frequency computed from Langmuir probe measurements are within 25% of the plasma frequency indicated by the radio frequency measurements. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8548 HARMONIC GENERATION IN PLASMAS. Jerrold Henry Krenz. Thesis, Stanford, Calif., Stanford Univ., 1964. 149p.

The generation of harmonics due to the nonlinear properties of a microwave plasma discharge is investigated theoretically and experimentally. The nonlinear effects of collisions, spatial variations of r-f electric field and plasma density, and sheaths are analyzed. In order to obtain the harmonic current due to a velocity-dependent collision frequency, the velocity distribution function is expanded in terms of spatial and time harmonics. By means of successive partial integrations with appropriate approximations, the third harmonic current for low collision frequencies is obtained in a particularly convenient form. It is shown that the effects of collisions constitute an inefficient method of harmonic generation and cannot account for the observed harmonics. The reactive nature of spatial variations is shown to result in particularly strong harmonics. Harmonic currents result from both a nonuniform r-f electric field and a nonuniform plasma density. A detailed analysis for the second harmonic generated with a resonant spherical plasma is presented. Harmonics higher than the second are found to depend very strongly upon the plasma sheath region. Preliminary experimental results with various modifications of a probe discharge are presented together with impedance measurements. The spatial variation theory is shown to account for the second harmonic. Experimental results obtained using a spherical plasma of the type employed by Swan are also reported. Efficiencies as high as 25% for the second harmonic are readily obtained. Techniques by which a stable, well-matched discharge may be maintained by means of a uhf source are described. As an offshoot of the harmonic generation investigation, parametric oscillations at half the driving frequency were observed. (A.G.W.)

8549 NUMERICAL CALCULATIONS RELATED TO THE RF PROPERTIES OF THE PLASMA SHEATH. John Milan Pavkovich. Thesis, Stanford, Calif., Stanford Univ., 1964. 184p.

A detailed r-f theory of the sheath is presented. The complete collisionless Boltzmann equation is used to derive a linear integral equation for the r-f electric field through the sheath. The analysis is one-dimensional. This integral equation is solved numerically for a semi-infinite uniform plasma bounded by a sheath defined by a parabolic d-c potential. A Maxwellian distribution of velocities is assumed for all computations. The results show that it is reasonable to assume that the normal component of displacement is continuous but that extra waves are set up near the boundary, which decay as one moves into the uniform plasma. These waves give rise to a sheath impedance. If one treats the plasma as a dielectric, this impedance gives rise to a small discontinuity in the tangential component of electric field. In many cases this discontinuity is negligible. However, the impedance does contain a resistive component corresponding to Landau damping, which is quite important in the consideration of loss. In none of the computations has this resistive component become negative for a Maxwellian distribution, and thus one is led to predict no oscillations in

the sheath. The results further show that for frequencies below the plasma frequency, the field reverses from inside to outside as expected. A pressure-type theory is also presented. This theory is based on moments of the collisionless Boltzmann equation. The results do not agree very well with results of the more exact theory. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8550 INTERACTION OF NEUTRAL PLASMA STREAMS WITH A MAGNETIC DIPOLE FIELD. James William Byrd. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 91p.

The interaction of a neutral ion plasma with a magnetic dipole field is investigated. The plasma flows down the axis of the dipole. Particular interest centers around the perturbation induced in the dipole field. A macroscopic, non-viscous theory is used in the investigation. Maxwell's equations along with the appropriate conservation equations are employed to describe the plasma. Integral transforms are introduced to transform the time out of the equations and the resulting space-dependent problem is studied. The method is then applied to two simple problems whose solutions are well-known in order to demonstrate its application. Investigation of the dipole problem yields expressions for the transient behavior of the magnetic field in closed form. The perturbation is initially zero, goes through a peak, and then decays slowly in time. Closed-form expressions for the velocity distributions are obtained. The results shown in this work lend definite support to this method of approach. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8551 THE PLASMA TEST PARTICLE PROBLEM. Cyril William Hirt. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 158p.

A charged test particle passing through an electron plasma is subject to a drag force. The calculation of the drag, when the test particle's velocity is maintained at a constant value, is referred to as the plasma test particle problem. Previous treatments of the plasma test particle problem are reviewed. These are the binary collision, linear hydrodynamic, dielectric constant, and linear Landau-Vlasov treatments. In each case the source of the logarithmic divergence in the drag expression is fully discussed. A modified linear solution of the hydrodynamic equations is described. This solution leads to a convergent drag expression. The hydrodynamic description of the test particle problem is basically a macroscopic description. A more detailed microscopic solution of the test particle problem in terms of the Landau-Vlasov equation, similar to the modified linear solution of the hydrodynamic equations, is obtained. A convergent expression for the drag is given that is exact for a slow moving test particle, and which retains the qualitative features of an exact solution when the test particle speed is greater than the mean thermal electron speed. The derivation of a spatially homogeneous electron plasma kinetic (transport) equation is discussed. Several electron plasma kinetic equations frequently used are reviewed. These kinetic equations contain the same logarithmic divergences encountered in the test particle problem. The source of these divergences is shown. Convergent test particle theories are further developed to give a convergent electron plasma kinetic equation. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8552 DETERMINATION OF THE PARAMETERS GOVERNING ELECTROMAGNETIC WAVE PROPAGATION IN A MOVING PLASMA. James Robert Collier. Thesis, Columbus, Ohio, Ohio State Univ., 1964. 87p.

The problem of electromagnetic wave propagation in an unbounded, moving, dissipative medium is treated theoretically. The first order correction term for the characteristic complex wave number is deduced. The real part of this term exhibits the familiar Fresnel drag coefficient, while the dissipative term does not. The theory is then applied to the moving medium in a wave guide. Expressions for the field components are derived for both the transverse electric and transverse magnetic cases for both rectangular and circular wave guides. When the velocity of the medium is zero, the expressions obtained for the characteristic wave vectors, which can be found from classical theory, reduce to those of the medium at rest. The electron density and collision frequency in the precursor region of a shock wave are determined experimentally. The fundamental electromagnetic propagating mode (TE_{11}) is excited in a shock tube and reflected from the oncoming shock front. The resulting standing wave pattern, which moves with the shock front, is monitored by an appropriately placed probe and displayed on an oscilloscope. The oscillograms are then analyzed with the aid of a computer program to determine the plasma parameters. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8553 IONIZATION AND RECOMBINATION IN CESIUM-SEEDED PLASMAS NEAR THERMAL EQUILIBRIUM. L. P. Harris (General Electric Co., Schenectady, N. Y.). 26p. (CONF-364-11)

From 16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963.

Measurements were made of electron-density relaxation in Cs-seeded plasmas perturbed from thermal equilibrium at 1500 to 2000°K. The gases consisted of 0.1 to 20 torr Cs vapor in atmospheric pressure Ar or He. Electron densities ranged over 1.9×10^{11} to 3.8×10^{13} cm^{-3} and relaxation times over 30×10^{-6} to 50×10^{-3} second. An analysis was developed that relates the measured relaxation times to the rate constants for the electron production and loss processes in the plasma. The results indicate that charge production and loss are dominated by the atomic-ion process $Cs + e + 3.89\ ev \rightleftharpoons Cs^+ + 2e$ at the higher temperatures, and by the molecular-ion process $Cs + Cs + 2.82\ ev \rightleftharpoons Cs_2^+ + e$ at the lower temperatures and higher Cs pressures. At the lower temperatures and lower Cs pressures the dominant process is ambipolar diffusion. The results obtained when the atomic-ion process dominates agree well with calculations based on the equilibrium properties of the gas and recent theory for two-electron, three-body recombination. The rate of the molecular-ion process corresponds to a two-body recombination coefficient of approximately 1×10^{-6} cm^3/sec at 1250 to 1400°C, a value small relative to that derived from earlier experiments. All evidence indicates that, despite their numerical preponderance, the Ar and He atoms play no significant roles beyond those of thermal bath and diffusion barrier. (auth)

8554 AN ANALYSIS OF THE BEHAVIOR OF THE RESONANCE PROBE. R. S. Harp (Stanford Univ., Calif.). 8p. (CONF-471-46)

From American Physical Society, 5th Annual Meeting, San Diego, Calif., Nov. 1963.

Confirming data are presented to show that the d-c current collected by metal probes immersed in plasma are not at plasma frequency as had been heretofore assumed. A new interpretation of frequency results that depends on sheath effects is given. (J.R.D.)

8555 COMPARISON OF A FEW METHODS FOR MEASURING THE DIFFUSION RATE OF PLASMA ACROSS A MAGNETIC FIELD. F. Boeschoten, K. Geissler, and G. Siller (Institut für Plasmaphysik, Garching, Ger.). 16p. (CONF-471-49)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

Theoretical aspects of plasma diffusion in magnetic fields are discussed. It is noted that experimental measurements indicate that the diffusion is collisional. Data and discussion are included on stationary plasma measurements, decaying plasma diffusion coefficient measurements, and measurement of diffusion waves in plasma. (J.R.D.)

8556 ELECTRON DENSITY MEASUREMENTS IN THE MAGNETICALLY CONFINED ARC. C. K. McLane, S. Takeda, W. E. Thomas, Jr., and R. C. Thompson (National Bureau of Standards, Washington, D. C.). 23p. (CONF-471-50)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

Methods used to obtain electron density as a function of radius in a magnetically confined, low pressure Ar arc included use of the phase shift of a reflected 35 GHz microwave, and density determination from the ion saturation current to a Langmuir probe. In another determination the

broadening of the Hβ line emitted by a small quantity of added H_2 was used. Agreement among the methods is satisfactory; the electron density at the axis of this discharge is of order 10^{14} cm^{-3} in agreement with results obtained by others for discharges of similar type. (auth)

8557 RESEARCH ON A ONE-INCH-SQUARE LINEAR D-C PLASMA ACCELERATOR. A. F. Carter, G. P. Wood, D. R. McFarland, and W. R. Weaver (Langley Research Center, Hampton, Va.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-699, 25p. $1.00. (CONF-640801-19).

From 4th Electric Propulsion Conference, Philadelphia.

Recent results from a research program are reported for an accelerator that has a channel 1 in. square and 12 in. long. This accelerator uses N seeded with 0.3% mole fraction Cs and operates at relatively high-pressure, 50 mm Hg, and high magnetic field, 11,500 gauss. Power input to the accelerator is about 360 kw with about 50 amp through each of 24 electrode pairs. The 1200-v axial potential difference that is self-generated in the plasma between the ends of the accelerator has posed operational problems. This high voltage tends to find closed circuits to ground and back through many paths. Steps taken to alleviate these problems are described. Another problem is the erosion of the trailing edges of anodes and adjacent insulators because of the concentration of currents there due to large values of $\omega\tau$. Experience with this effect is described. Time-of-flight velocity measurements were made with injected spark and image-converter framing camera. Velocity at entrance is 6500 ft/sec and at exit 20,000 ft/sec and exit density is 10^{-4} lb/ft^3. (auth)

Shielding

8558 (HW-83784) BREMRAD—A COMPUTER CODE FOR EXTERNAL AND INTERNAL BREMSSTRAHLUNG CALCULATIONS. H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 23p. Dep.; $2.00(OTS).

A Fortran II program for an IBM 7090 computer was developed for calculating external and internal bremsstrahlung. The thick target cross section for external bremsstrahlung from monoenergetic electrons was found to differ significantly at low energies from a linear approximation of bremsstrahlung intensity. (auth)

8559 (TO-B-63-73) MONTE CARLO CODES TO INVESTIGATE THE REFLECTION AND TRANSMISSION OF GAMMA RAYS AND NEUTRONS IN HOMOGENEOUS AND HETEROGENEOUS SLABS. VOLUME I. GAMMA-RAY CODE. Final Report. Dominic J. Raso and Samuel S. Holland (Technical Operations Research, Burlington, Mass.). Oct. 8, 1963. Contract DA-18-108-405-CML-1023. 71p. (AD-422292).

Multipurpose gamma ray and neutron Monte Carlo programs for describing the characteristics (E,ω,Z) of photons or neutrons emergent (backscattered or transmitted) from slabs have been written. The programs are set up to investigate gamma ray or neutron backscattering, absorption, and transmission in one, two, or three layers of different media. The information that may be obtained includes (1) the number backscattered or transmitted; (2) the energy backscattered or transmitted; and (3) the angular distribution of the emergent number, energy, or dose. Sample results are given for both incident gamma rays and neutrons. "Gamma Ray Code" is the first of three volumes of the final report on Contract DA-18-108-405-CML-1023, CPL-405-13163. Volume II (TO-B 63-82) is "Neutron Codes" and Volume III (TO-B 63-83) is "Results." (auth)

8560 MASS AND MAGNETIC DIPOLE SHIELDING AGAINST ELECTRONS OF THE ARTIFICIAL RADIATION BELT. A. Bhattacharjie and I. Michael (Northrop Space Labs., Hawthorne, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 2: 2198-201(Dec. 1964).

Computations of magnetic shielding system masses required for protection against electrons of various energies were performed. A comparison of the required shielding masses is obtained for a space vehicle traversing circular orbits through the anomaly in the artificial radiation belt (ARB) at altitudes of 200, 400, 600, and 800 km and inclined at 30° to the earth's equatorial plane: first with a magnetic superconducting solenoidal shielding system approximated by a point dipole and then with a two-layer composite material shielding system consisting of an outer layer of aluminum and an inner layer of lead. The aluminum thickness equaled the practical range of 10-Mev electrons, and the lead was used to attenuate the bremsstrahlung to specified skin dose rates. The averaged electron flux in ARB, used in estimating dose, was computed to be sufficiently accurate for missions not shorter than 100 hr and more accurate for longer missions. The material shielding mass, primarily designed for protection when appreciable bremsstrahlung occur, was at best (no lead) an order of magnitude larger than that of the magnetic shielding system. The mass of the cryogenic system was neglected, being a fraction of the combined mass of the solenoid and support structure. (auth)

8561 MONTE-CARLO METHOD FOR CALCULATION OF γ RADIATION PENETRATION THROUGH SUBSTANCES. L. M. Shirkin. At. Energ. (USSR), 17: 509-11(Dec. 1964).

A calculation method was developed for reducing the bulk of formulas used in Monte-Carlo calculations. The method permits a comparatively easy manual calculation of 20 to 60 events per hour. The method is demonstrated in calculations of γ path, the Compton scattering angle, and the angle between the normal to a plane and the γ direction following (n + 1) scatterings. The results show that no accuracy is lost. (R.V.J.)

8562 CONCRETE BLOCKS FOR RADIATION SHIELDING. R. M. Cowdroy (Australia Atomic Energy Commission, Lucas Heights, New South Wales). At. Energy Australia, 7: No. 4, 27-30(Oct. 1964).

A shielded enclosure made of precast blocks was compared with an enclosure with poured concrete walls. It was found that the radiation attenuation in the two walls is about the same. (J.R.D.)

8563 SHIELDING FOR RADIOISOTOPE BREMSSTRAHLUNG SOURCES $Sr^{90} + Y^{90}$. T. Florkowski (Inst. for Radioisotope Techniques, Academy of Mining and Metallurgy, Krakow). Intern. J. Appl. Radiation Isotopes, 15: 579-86(Oct. 1964).

A method of calculating shielding for radioactive bremsstrahlung sources with $^{90}Sr + ^{90}Y$ as β emitters and lead targets is described. Based on theoretical assumptions, the bremsstrahlung yield of β particles and the photon spectrum as well as the dose rates for various lead shield thicknesses were calculated. A good agreement with experimental values was obtained, both in the shape of the spectrum and the dose rates for various lead thicknesses. A procedure for shield thickness choice in a case of a $^{90}Sr + ^{90}Y$/Pb source is given. (auth)

8564 HIGH WATER CONTENT SHIELDING CONCRETE WITH IRON AND BAUXITE AGGREGATES. Gy. Kunszt (Epitesugyi Miniszterium, Budapest). Nucl. Struct. Eng., 1: 118-26(Jan. 1965).

Since limonite ores available in Hungary do not satisfy the general quality requirements for reactor shielding concrete aggregates because of insufficient crystallinic water and low density, the possibilities of using bauxite instead of limonite were explored. Though the density of bauxite is still lower than that of Hungarian limonites, there are types with more than 25% hydrate water content. Use of bauxite as concrete aggregate resulted in a hydrate water content exceeding that of best limonite concretes of abroad, while sufficient specific density can be provided by the addition of scrap iron. This new type of concrete has adequate mechanical and thermal characteristics, and a hydration water content to be considered stable in spite of chemical reactions between the $Ca(OH)_2$ from the cement and bauxite. Empirical formulas for the relations between concrete composition and neutron attenuation were established. (auth)

8565 SOME EXPERIMENTS ON THE RELATIVE PROTECTION OF GAS COOLED REACTORS AND COMPARISON WITH CALCULATIONS. P. Lafore (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Nucl. Struct. Eng., 1: 127-31(Jan. 1965). (In French)

Experiments designed to yield information on lateral shielding and in particular on the sources of capture-gamma rays in graphite reactors were carried out using natural-uranium plate emitting 4×10^7 n cm^{-2} s^{-1}. The experimental results obtained in different graphite, Fe, and concrete mock-ups were used to work out methods of calculation applicable to reactors. These methods were checked by measurements made in the lateral shielding of the EDF-1 reactor. To assess the damage liable to occur in pressure vessels, the changes occurring in the mechanical characteristics of steel were related to the integrated flux measured by means of P detectors; the attenuation in the graphite of the flux responsible for the damage and the flux measured with the P detectors were compared. In reactors fitted with exchangers where the inside of the pressure vessel generally has to be accessible during shutdown, the activation of structural materials brought about by neutrons from perforated reflectors is a particularly important problem. A number of preliminary investigations were carried out in the MARIUS assembly. These involved mainly the study of fast-neutron sources inside the core. This work is to be continued in a sub-critical mock-up being built at Fontenay-aux-Roses. (auth)

8566 TOTAL ATTENUATION COEFFICIENTS FOR 5- TO 11-Mev PHOTONS. R. H. Barlett and D. J. Donahue (Pennsylvania State Univ., University Park). Phys. Rev., 137: A523-6(Jan. 18, 1965).

Monoenergetic neutron-capture gamma rays were used to measure gamma-ray attenuation coefficients of Be, Al, Cu, Sn, and Pb at energies of 5.435, 6.405, 7.725, and 10.833 Mev. These coefficients were obtained with uncertainties of from 0.3 to 0.5%. Results are in reasonable agreement with calculated coefficients. Analysis of the results shows that, in the energy range studied, if Compton scattering can be calculated from the Klein-Nishina formula without radiative corrections, pair production in the Coulomb field of an electron is best predicted by the theory of Borsellino. (auth)

8567 GAMMA DOSAGE IN THE VICINITY OF CYLINDRICAL VOIDS IN SHIELDS. Donald Stuart Sasscer. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 126p.

The Monte Carlo technique was used to determine the rate at which energy is absorbed in water at the surface of cylindrical ducts through an otherwise homogeneous shield assumed to be infinite in extent and 200 cm thick. The centerline of the ducts was perpendicular to the direction of infinite extent and a one-disintegration-per-second, isotropic, point source of cobalt-60 was located on the centerline at midthickness. The positions of the first collisions were determined by a programmed sequence of positions between 0.5 and 27.5 cm from the duct at which initial collisions were allowed to occur. The rate at which energy was absorbed at the surface of the ducts having length to radius ratios of 10, 26.25, 50, and 100 was obtained as a function of distance along the centerline of the ducts. The results were analyzed dimensionally by use of the Buckingham Pi theorem, which predicted that the basic variables could be grouped into six dimensionless Pi terms. The manner in which the energy absorption buildup factor (π_1) varies at the surface of ducts six mean free paths (mfp) in length (π_3) is determined as a function of the distance from the source (π_2) for ducts with various ratios of length of radius (π_4). The energy absorption buildup factor at the surface of a duct with L/R = 100 was found to have a maximum value of 48 between three and four mfp from the source. However, the energy absorption buildup factor was found to be a continuously increasing function of distance from the source for a duct with L/R = 10, having a maximum value of 21 at six mfp from the source. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

REACTOR TECHNOLOGY

General

8568 (EURAEC-1178) STABILITY TESTS FOR BOILING-WATER REACTOR. Quarterly Report No. 1, April 1–June 30, 1964. (Allgemeine Elektrizitatsgesellschaft, Frankfurt am Main). Work Performed under Joint Research and Development Program. Contract 020-64-4 TEED. 52p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Descriptions of the test rig and the regulation of the main control parameters are given along with accounts of the modifications and experiments carried out during the period to improve control. The work carried out to improve the test instrumentation is described in which detailed experimental and theoretical studies into the behavior in time of the flowmeter system are emphasized. Initial disturbing influences which affected the flowmeter system on the test rig were eliminated. Three of the pressure differential gages designed for measuring frictional grip drops broke down when switched on. The defect in one of the gages was removed by modifying the design. The development of the measuring apparatus for determining the density of the steam–water mixture in the heating section was largely completed and work begun on assembling the unit. Tests were carried out on two servo-motors to determine whether they could be used to drive the velocity modulator. (auth)

8569 (HW-83443(Rev.1)) COMPARISON OF BOILING BURNOUT DATA FOR 19-ROD BUNDLES IN HORIZONTAL AND VERTICAL POSITIONS. G. M. Hesson, D. E. Fitzsimmons, and J. M. Batch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 15p. Dep.; $2.00 (OTS).

A total of 15 boiling burnout points was determined with an electrically heated model of a 19-rod bundle fuel element in a vertical position. The test section had a heated length of 76 in. and a spacing of 0.050 in. between rods maintained with a wire wrapped on a 9 in. pitch around 12 of the rods. The experimental data were obtained at coolant flow rates from 0.5 to 3×10^6 lb/(hr) (ft^2), and at outlet qualities from 10 to 50%. Results of these experiments were compared with data obtained with the same test section in a horizontal position. The data show little or no difference in the boiling burnout heat fluxes for vertical and horizontal positions when the mass flow rate is 10^6 lb/(hr)(ft^2), or greater. At a mass flow rate of 0.5×10^6 lb/(hr)(ft^2), however, the boiling burnout heat flux for a given outlet enthalpy was as much as 50% higher in the vertical position. (auth)

8570 (IITRI-T6042-11) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, June–July 1964. E. V. Gallagher, comp. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Crushable Shield Analysis and Design. Debugging activities on the SWIMM (Stress Waves in Multilayered Media) code were continued. One error check which was incorporated into the code is described. Shock Impingement Experiments on Crushable Shields. Dynamic data from shock tube tests for celotex were compared with those predicted by the computer code. Coolant Decompression Experiments and Analysis. Analysis of the data for the three-dimensional receiver vessel is discussed. The phenomenon where the liquid is near the diaphragm is described. (D.L.C.)

8571 DIGITAL USES OF COMPUTERS IN NUCLEAR ENGINEERING. J. J. Thompson (Univ. of New South Wales, Kensington, Australia). At. Energy Australia, 7: No. 4, 6-11(Oct. 1964).

Typical uses of computers in reactor engineering analysis are discussed. (J.R.D.)

8572 THE CHEMISTRY OF NUCLEAR REACTORS. C. M. Nicholls (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. Ind. (London), No. 39, 1649-53(Sept. 26, 1964).

Reactor materials and designs are reviewed. The chemistry of gas-cooled reactors is discussed in terms of coolant choice. Efforts employed on development of a single aqueous homogeneous reactor, being centered at the Oak Ridge National Laboratory, are outlined. The corrosion of metals by water is also discussed, and attempts to minimize corrosion by the choice of metals and with techniques for the purification and treatment of cooling water are cited. Safety problems arising from the fissile and radioactive nature of the fuel materials are presented in terms of eliminating uncontrolled nuclear chain reactions and excessive releases of toxic materials to the atmosphere. (BBB)

8573 STUDIES ON THE RECONCENTRATION OF DEGRADED HEAVY WATER. Akishige Harada and Yasuo Kurihara (Showa Denko Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 6: 628-32(Nov. 1964). (In Japanese)

In heavy water reactors large amounts of heavy water degrade during operation and cannot be used without reconcentration. To reconcentrate the degraded heavy water, a new plant was developed having a capacity of 5 t/yr. The plant is now operating and a bigger plant with a capacity of 200 t/yr is being designed. (auth)

Auxiliaries and Components

Refer also to abstract 8565.

8574 (IITRI-578P22-9) STUDIES OF REACTOR CONTAINMENT STRUCTURES. Summary Report. N. A. Weil, M. A. Salmon, R. L. Chiapetta, H. S. Napadensky, and W. D. Pilkey (Illinois Inst. of Tech., Chicago. IIT Research Inst.). [1963]. Contract AT(11-1)-578. 366p. Dep.; $7.00(cy), 6(mn); OTS.

Structural response of containment vessels was studied using cylindrical shells, spheres, and cylinders as reference geometries. The effects of openings on the strength of containment vessels were studied analytically for thin plates, spherical shell caps, and shallow cylindrical shells in an effort to determine the effects of unreinforced and reinforced circular openings on their behavior in the plastic range. Preliminary development and testing of specimens and instrumentation for bulging experiments on finite-length pressurized cylinders of low-carbon steel, high-strength low-alloy steel, and an austentic stainless steel are reported; some preliminary test results are also given. The progress in development of a pressure-vessel handbook for use by reactor systems designers is reported. (R.E.U.)

8575 (NAA-SR-6463) FUEL CLADDING FAILURE MONITOR FOR SODIUM REACTORS. R. J. Hall, R. E. Avery, and E. A. Moore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 26p. Dep.; $0.50(OTS).

Fuel cladding failures in the Sodium Reactor Experiment are detected as a result of the rapid increase in ^{133}Xe activity. A continuous reactor cover-gas circulating system and scintillation spectrometer form the major components of a fission product monitoring system. The fission product monitor can be employed to measure gross activity, perform a spectrum analysis of the reactor core gas, or measure the particular radioactive isotope in question. The scintillation spectrometer is capable of measuring ^{133}Xe activity down to a low concentration of 10^{-5} $\mu C/cc$ with good resolution. (auth)

8576 (SRIA-117) CONTAINMENT OF FRAGMENTS FROM A RUNAWAY REACTOR. Final Report. R. W. Gates (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). Feb. 15, 1964. Contract AT(04-3)-115. 141p. Dep.; $4.00(cy), 3(mn) OTS.

A technique was developed for the study of the events associated with a reactor runaway. This technique consists of a study of scale models of reactors in which a scaled simulated energy release has been produced by chemical energy sources. The possibility of scaling of the results of such model studies to full-sized reactors was studied. In addition, the effects of the variation of some parameters, such as source energy and period upon the reactor models, are described. The reactor model was designed to be a compromise between an accurate scale model of an actual reactor and a simplified unit which could be easily analyzed. The model incorporates the three major components of reactors: the pressure vessel, the concrete biological shield, and the access plug. The energy source was simulated with a low-detonation-velocity explosive mixture called Calpoke which produces chiefly solid products on detonation. The damage sustained by the models during simulated excursions was characterized by the velocity, the number, the weight, and the distribution of the fragments, and by the distortion of the pressure vessel. Scaling studies were performed with three sizes of models, a $^1/_8$, a $^1/_{12}$, and a $^1/_{24}$-scale. The results obtained indicated that simple geometrical scaling laws were not valid for this system. However, systematic empirical scaling relationships were developed. These relationships permit estimates to be made of the results of full-scale excursions. An example is shown of a 1300 Mw-sec, 1 msec excursion scaled up from data obtained from $^1/_{24}$-scale model shots. This indicates that such an excursion could be expected to produce 350 significant fragments with an average weight of 4300 lbs, a maximum weight of 44,000 lbs, and a maximum fragment velocity of 98 ft/sec. The pressure pulse within the model vessel was measured with an F-K gage (Hopkinson bar type); the results indicated maximum pressures in the range of 20,000 psi. The information from these measurements was used in an analytical program to determine the behavior of the concrete and vessel walls. The results of the program agree well with the experimental results and indicate that the damage produced by an excursion can be predicted from theoretical analysis. An attempt was made to see if the energy in the various components of the model system would balance with the energy input from the source. The kinetic energy of the fragments, the work done distorting the vessel walls, and the temperature content of the vessel and its contents after the shot were all determined. The work indicated that of the total energy input only 1.5 to 4.1% went into fragment kinetic energy and 2.7 to 3.2% vessel strain energy; the remainder heated the vessel and its contents. The temperature rise amounted to about 9°C. Highly accurate temperature measurements are required to achieve a close balance. The studies showed that as the source energy increased with the period remaining constant, the fragmentation damage increased. If the period increased with the energy remaining constant, the fragmentation damage decreased. The inclusion of an air gap between the vessel and the concrete causes the damage to markedly decrease. The inclusion of a gas space within the pressure vessel also results in decreased damage. The rupture of the pressure vessel causes a substantial increase in fragment velocities and, hence, produces fragments of greater hazard to the containment shield. (auth)

8577 INSTRUMENTATION IN NUCLEAR POWER STATIONS. Tatsuo Yuri. Fuji Jiho, 36: 779-84([Sept.] 1963). (In Japanese)

Since October 1956, the United Kingdom has been installing gas cooled power reactors. The total capacity will be 5000 Mw(e) by 1967. A 150 Mw(e) nuclear power station of this type will be completed in 1965 in Tokaimura, Japan. Aspects of instrumentation of nuclear stations in the United Kingdom are reviewed, and future trends are traced. (auth)

8578 A GRAPHICAL DESIGN OF AN OPTIMUM CONTROL SYSTEM TO MINIMIZE BOILING REACTOR NOISE. L. Rolf Peterson and Lynn E. Weaver (Univ. of Arizona, Tucson). Nucl. Sci. Eng., 21: 40-8(Jan. 1965).

A graphical technique was used to determine an optimum reactor control system that will minimize boiling reactor noise. This technique permits a considerable physical insight into the basic structural properties of optimum control systems to minimize reactor noise. Contrary to previous results, it was found that a reactor control system independent of reactor power level except for a gain constant could be designed that would minimize boiling noise at all power levels. This, in effect, eliminates the need for a complex adaptive control system to account for the dependence of the optimum reactor control system on reactor power level. Simulation studies verified these findings. (auth)

8579 STRESS ANALYSIS OF PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS WITH SECANTIAL CABLE ARRANGEMENT. Radim Servit (Technical Univ., Prague). Nucl. Struct. Eng., 1: 47-60(Jan. 1965).

Equations describing the stress behavior of a thick-walled cylindrical concrete pressure vessel prestressed by secantial and longitudinal cables, at various stages of construction and operation of the reactor, are presented. The treatment is based on the assumption that the material behaves elastically and that the cylinder faces remain plane upon loading. The stress is described for circumferential secant prestressing and longitudinal prestressing, for internal pressure loading and for heating of the wall varying in radial direction. The effects of successive prestressing of secantial cables with respect to stress is also analyzed and possibilities are indicated on how to eliminate this effect. (auth)

8580 COMPUTATIONS FOR PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS USING DYNAMIC RELAXATION. J. R. H. Otter (Rendel, Palmer and Tritton, Consulting and Designing Chartered Civil Engineers, London). Nucl. Struct. Eng., 1: 61-75(Jan. 1965).

A new digital computer method of computation of the stresses and displacements in thick-walled pressure vessels is described. The method is developed from a similar method used for the solution of the tidal flow equations in one- and two-dimensions. Two sample calculations are given for one-dimensional elastic and thermoelastic problems in a bar. The technique is developed for axially symmetric pressure vessels using cylindrical polar coordinates and the boundary conditions, the damping factor and the stability criterion to be used, and the number of iterations required in the calculations are discussed. A typical example is given of calculations for a pressure vessel. The possibility of estimating stress or temperature dependent creep in the frame of the dynamic relaxation method is discussed. The application of the method to other forms of partial differential equation is suggested. (auth)

8581 A STATUS REPORT ON PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL TECHNOLOGY. M. Bender (Oak Ridge National Lab., Tenn.). Nucl. Struct. Eng., 1: 83-90(Jan. 1965). (ORNL-P-176)

The evolution of concrete pressure vessel design is traced, and a summary of the current applications of prestressed concrete for reactor pressure vessels is presented. Important design considerations and methods for design evaluation are discussed. It is concluded that a basis for design compatible with the ACI and ASME pressure vessel codes is evolving, but the maximum pressure limits for which prestressed concrete can be used are yet to be established. (auth)

8582 NOTE ON STRESS ANALYSIS OF PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS. T. A. Jaeger (Technische Universität, Berlin). Nucl. Struct. Eng., 1: 133-6(Jan. 1965).

Developments in structural engineering of prestressed concrete reactor pressure vessels are discussed. A discussion is presented concerning radioinduced heat generation in structures, elasticity and thermoelasticity, and thermoviscoelasticity. (J.R.D.)

8583 SHIM CONTROL OF HEAVY-WATER MODERATED POWER REACTORS BY REMOVAL OF LIGHT-WATER POISON. Charles White Sayles. Thesis, (Ames, Iowa, Iowa State Univ. of Science and Tech.), 1964. 101p.

The feasibility of shim controlling a heavy-water (D_2O) moderated power reactor by removing a light-water (H_2O) poison was studied. Shim control is provided in a power reactor to compensate for the gradual changes in excess reactivity due to depletion of fissionable fuel and the accumulation of fission products. If hydrogen is in the form of light water mixed with the heavy-water moderator and coolant it could be removed by distillation to accomplish shim control. To show that this method can be used to control shim, a reactor model that would be capable of producing 250 electrical megawatts was selected. With this reactor model the concentration of light water required to shim control was determined as a function of time. The concentration is initially 3.69 mol per cent H_2O, and reaches a maximum of 5.2 mol per cent before decreasing to 0.60 mol per cent H_2O. Based on these concentrations, a distillation unit is specified that will remove the light water at the proper rate. The cost of this distillation unit is compared with the cost of shim control rods. This method has a disadvantage of 1.4 mill per kilowatt hour. Also discussed are reactivity coefficients and possible improvements that would increase the attainable fuel burnup and reduce the heavy water inventory. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

8584 GRIPPING DEVICE, PARTICULARLY FOR HANDLING NUCLEAR REACTOR FUEL ELEMENTS. Bernard Leclere, Georges Lemesle, Jean Bernard Morange, and Jean Vivien (to Commissariat à l'Energie Atomique). British Patent 971,438. Sept. 30, 1964. Priority date Sept. 26, 1962, France.

The gripping device described consists of two members, one of which is carried by the control cable and can be released from the other if the latter jams so that the device can be re-equipped with a new member without withdrawing it from the reactor. The two members, a gripper body having automatically operated jaws and an end part provided with means for raising and lowering the device, are connected by a coupling device. The coupling device can be connected by inserting the end part and the gripper into one another and disconnected by applying to the gripping device a tractive force greater than a predetermined value. (A.G.W.)

8585 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Terence Edward Gouvenot Gardiner (to Bristol Aerojet Ltd.). British Patent 971,501. Sept. 30, 1964. Filed Sept. 16, 1959.

A strut is described for supporting a vertical column of fuel elements in a fuel element channel of a nuclear reactor of the kind in which a cooling fluid flows upward through the channel past the fuel elements. The strut incorporates a valve capable of applying a variable restriction on a fluid flow through a channel in which the strut is used. The valve operates in response to the weight of fuel elements supported by the strut such that the lifting of all the fuel elements off the strut increases the restriction to a maximum. The strut consists of a body part and a support member slidingly mounted in the body part. In use the support part extends upward and carries the fuel elements. The valve consists of fixed vanes projecting from the body part and a vaned member encircling the body part and rotatably mounted adjacent the fixed vanes. Rotation of the vaned member serves to restrict the passages between the fixed vanes. The movable vane member and the support member are interconnected to effect valve operation as aforementioned. (A.G.W.)

8586 IMPROVEMENTS RELATING TO SERVICING SYSTEMS FOR NUCLEAR REACTORS. Everett Long (to English Electric Co. Ltd.). British Patent 972,075. Oct. 7, 1964. Filed Jan. 31, 1961.

The servicing system described includes a servicing machine arranged to provide access to the interior of a reactor vessel and first and second pipe means connecting the servicing machine with first and second portions respectively of the cooling circuit. The portions of the cooling circuit connected are so disposed that there is a substantial difference in reactor coolant pressure between them, whereby some reactor coolant may be continuously circulated through the servicing machine and the cooling circuit. The servicing machine is arranged to be movable between a plurality of positions giving access to the interior of the vessel, and the pipe means are so arranged as to allow such movement. (A.G.W.)

8587 IMPROVEMENTS IN AND RELATING TO REACTOR CORES. (to Reactor Centrum Nederland). British Patent 972,101. Oct. 7, 1964. Priority date Nov. 30, 1961, Netherlands.

A supporting lattice is described for a reactor core in which fissionable material is used in the shape of thin vertical rods extending side by side at predetermined distances from one another. The lattice is formed of strips of material that extend side by side and at least alternate ones of which extend in a zig-zag shape. The strips are connected together at the crests of the zig-zags in such a manner that the strips repeatedly meet and diverge from one another to form a network. The strips are provided with resilient lips to hold the rods spaced from the strips. Strip material 0.2 mm thick is used in order to cause minimum resistance to moderator-coolant flow. The supporting lattices are mounted in sleeves of sheet material and are kept in place by supporting members connected to the sleeves. (A.G.W.)

8588 IMPROVEMENTS IN NUCLEAR REACTOR SHIELDING. (to Babcock and Wilcox Ltd.). British Patent 972,190. Oct. 7, 1964. Priority date Feb. 25, 1960, Germany.

A nuclear reactor having a core enclosed within a spherical pressure vessel and having its sides of a shape disconforming with the opposed surfaces of the pressure vessel may be provided with a biological shield disposed partly within and partly without the pressure vessel. The first part of the shield, which is within the pressure vessel, encircles the core and permits a reduction in diameter of the second part of the shield, which is outside the pressure vessel. The part of the shield within the pressure vessel is enclosed within a gas-tight casing. A passage of generally annular cross section through which coolant may circulate is formed between the first part of the shield and the inner surface of the pressure vessel. (A.G.W.)

8589 IMPROVEMENTS IN OR RELATING TO IRRADIATION CAPSULES. Jean Gentil and Maurice Seguin (to Commissariat à l'Energie Atomique). British Patent 972,192. Oct. 7, 1964. Priority date Apr. 13, 1960, France.

An irradiation capsule for studying the behavior of samples of materials subjected to neutron bombardment consists of a tubular body shaped and adapted for insertion into a channel of a nuclear reactor. A pair of end pins projecting toward each other from the end wall of the tubular body and from the cover respectively support the sample between them in an axially centered position. Annular spaces communicating at their ends permit circulation of a gaseous fluid around the tubular wall and past the sample. A hermetically sealed cover is adapted to be sealed after the body has been filled with gas to a selected pressure. Means for measuring gas pressure and the rate of gas flow inside the capsule are provided. Electrical connectors extend through the cover and connect to electrical heating means and to thermocouples for temperature measurement. The unit is easily manufactured at a low price and is simple to operate. Several capsules may be arranged in the same reactor channel. (A.G.W.)

8590 CONTROL ROD FOR NUCLEAR REACTORS. Raphael Lopes Cardozo (to Europaische Atomgemeinschaft (Euratom). German Patent 1,173,192. July 2, 1964. Filed Apr. 5, 1962.

The control rod consists of two parts, which are movable about their respective axis and one of which surrounds the other entirely. The outer rod is provided with a channel with an axis parallel with but eccentric to the axis of rota-

tion of the outer rod. A second rod, also provided with an eccentric channel, is fitted into the channel of the outer rod. Because of the channel in the inner rod the control rod serves also as an experimental channel into which measuring devices or irradiation samples can be inserted. (Gmelin Inst.)

8591 DEVICE FOR THE REGULATION OF A NUCLEAR REACTOR. Werner Spillmann (to Escher Wyss AG). German Patent 1,174,916. July 30, 1964. Priority date Sept. 13, 1959, [Switzerland].

A device for regulating a nuclear reactor is described. It consists of at least one pair of neutron-absorbing control elements, which are arranged on opposite sides of the reactor for insertion into it. The two elements of each pair are coupled together so that on operation of the regulating device they move simultaneously for substantially the same distance in opposite directions to each other. (Gmelin Inst.)

8592 ARRANGEMENT FOR THE EXTERNAL INDICATION OF THE TEMPERATURE WITHIN THE CORE OF A NUCLEAR REACTOR. Pierre Albert Alexandre Rault (to C.I.T. Compagnie Industrielle des Télécommunications). German Patent 1,178,525. Sept. 24, 1964. Priority date Mar. 13, 1959, France.

The arrangement comprises a pair of contacts on the wall of the fuel channel in the core of a nuclear reactor. They are set a distance apart, with a pair of corresponding contacts on the outside of the fuel elements. The contacts on the outside of the fuel elements are mechanically biased in such a way that they do not protrude as long as the fuel element is not in its final position in the fuel channel in which it touches the bottom of the channel. (Gmelin Inst.)

8593 HYDRAULIC OR PNEUMATIC CONTROL ROD DRIVE FOR NUCLEAR REACTORS. Otto Bjarsch (to Siemens-Schuckertwerke AG). German Patent 1,178,526. Sept. 24, 1964. Filed Nov. 29, 1960.

The drive comprises a guide channel extending from outside into the core, and a slidable piston disposed within the channel and engaged with the upper end of the control rod. The elongated piston has the shape of a driving stem on which racks are disposed. The wall of the channel is provided with protruding teeth. The cooling medium of the reactor is circulated through the slit between the driving stem and the channel in a by-pass circuit. The pressure differences in the main cooling circuit provides the force for actuating the drive. (Gmelin Inst.)

8594 SHIELDING FOR NUCLEAR REACTORS. Wilhelm Ringeis and H. Gerhard Fendler (to Licentia Patent-Verwaltungs GmbH). German Patent 1,178,527. Sept. 24, 1964. Filed Nov. 24, 1959.

A nuclear reactor has a biological shield, which is arranged from the pressure vessel or the heat insulator surrounding the pressure vessel so that a space is obtained in which there is another shielding material. The outer surface of the pressure vessel or of the heat insulator and the inner surface of the biological shield are coated with a layer of neutron-absorbing material. A cooling medium is circulated through the remaining space. (Gmelin Inst.)

8595 COOLING DEVICE FOR ENCASED CONTROL INSTRUMENTS IN A HIGH AMBIENT TEMPERATURE. John Henry Ellinger (to Europaische Atomgemeinschaft (Euratom)). German Patent 1,179,410. Oct. 8, 1964. Priority date Dec. 18, 1959, Great Britain.

An encased television camera is described, which is used within high temperature reactors. Between the impermeable outer casing and the instrument there is a porous, double-walled partition through which a liquid cooling medium is circulated. Cooling is achieved by evaporation of the cooling medium penetrating the porous walls. (Gmelin Inst.)

Criticality Studies

8596 (CRRP-1199) THE STOKE PROGRAMS FOR REACTOR FUELLING. W. M. Barss and P. M. Attree (Atomic Energy of Canada Ltd., Chalk River, Ont.). June 1964. 75p. (AECL-2058). Dep.; $3.00(AECL).

The STOKE computer programs simulate the performance of reactors that can be represented by a two-dimensional model, in R-Z geometry. The simulation represents the changing spatial distributions of neutron flux and fuel irradiation, taking into account both the passage of time and the mechanical shifting of fuel within the reactor. The programs are designed to test various fuel management rules by which the computer, like a reactor operator can first "recognize" when a fuel shift is required and then "execute" a shift that is selected from an analysis of the current state of the reactor, rather than from a fueling schedule prescribed in advance. In this way, reactor performance can be determined as a function of the fueling rules, with minimum dependence on the approximations involved in the calculations. For the CANDU reactor, STOKE has been used to develop two sets of fueling rules. Either set, with an appropriate initial fuel charge, is expected to avoid any serious loss of power output due to distortion of the flux or power distributions in the reactor. Although the fuel management rules embodied in the current version of STOKE are intended primarily for the CANDU reactor, the program is written so as to be modified conveniently for studying other reactors. (auth)

8597 (EIR-71) ON THE STABILITY OF STEAM-COOLED FAST REACTORS WITH CERAMIC FUEL. Paul Schmid (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Oct. 1964. 27p. Dep.(mn).

Revised Version of A/CONF.28/P/687, Abstracted in NSA, 18: 38496.

Stability of fast, steam-cooled, ceramic-fueled reactors is investigated. Two models (viz., a space-independent model assuming Newton's law of cooling with coupled heat transfer, and a space-dependent model including linear reactivity feedback from out-of-pile components) are considered, and each is used to derive stability criteria, from which the maximum permissible ratio of magnitudes of the positive steam void coefficient and the negative Doppler coefficient of reactivity can be determined. (T.F.H.)

8598 (EUR-1897.e) THE CONCEPT OF "NEUTRON IMPORTANCE" IN REACTOR PHYSICS. W. Matthes (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 34p. Dep.(mn).

A statistical theory of interactions between a neutron source and a neutron detection "instrument" via a neutron transmitting medium is developed. The instrument is taken to include means for measurement of reaction rates, coincidence rates, etc. The total measured effect in the instrument is the sum of all effects of individual source neutrons. The effect of a source neutron starting at $(P_0 t_0)$ on the instrument is called the "importance" I $(P_0 t_0)$ of the neutron. The importance function is then found by integrating over the source distribution. (R.E.U.)

8599 (EUR-2108.i) FONDAMENTI DELLA TEORIA DELLO SPETTRO DEI NEUTRONI TERMICI IN UN REATTORE NUCLEARE. (Outlines of Thermal Neutron Spectrum Theory in a Nuclear Reactor). V. Ardente and G. Rossi (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 95p. Dep.(mn).

After a general discussion of the energy-dependent transport equation, a basic introduction to the theory of scattering of thermal neutrons is given. Two typical space-dependent spectrum problems are presented and discussed. (auth)

8600 (KEA-205) BESTIMMUNG DER LOKALEN NEUTRONENFLUSSVERTEILUNG AN UNREGELMASSIGKEITEN DES REAKTORGITTERS. (Determination of Local Neutron Flux Distribution at Perturbations of the Reactor Lattice). R. Andres. P. Kilian, and A. Sauer (Allgemeine Elektrizitätsgesellschaft, Frankfurt am Main). Apr. 1964. 27p. Dep.(mn).

Investigations were made of the local neutron flux distribution in the environment of water splitting in light-water-moderated UO_2 rod lattices. Activation measurements were made in several segments of the AEG Argonaut

research reactor. The examinations of the measured flux distribution was carried out by three methods: from the Wigner-Wilkins spectrum, from two overlapping thermal spectra, and from a hardened Maxwellian distribution. Data are presented in tables and graphs. (M.C.G.)

8601 (NAA-SR-Memo-7891) MULTIGROUP CALCULATION METHODS WITH APPLICATION TO THE SGR CRITICAL EXPERIMENT. F. L. Fillmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 1, 1964. Contract AT-11-1-GEN-8. 69p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The adequacy of methods for treating certain features of multigroup calculations in graphite-moderated lattices was investigated. The features of most concern are: (1) thermal neutron spectrum effects arising from the separation of fuel and moderator; (2) resonance capture and fission; and (3) fast fission. Methods applicable to homogeneous or nearly homogeneous systems find extensive use in practice. These methods are included in the survey in order to assess their reliability and to obtain results that can be compared with results obtained from other more complex procedures more appropriate for lattices. The calculations are made for a set of critical assemblies so that experimental results are also available for comparison. An additional purpose of this report is to present a reasonably detailed description of the multigroup methods being considered and to indicate points where improvements appear to be warranted. Although certain improvements may be difficult to implement, a better understanding of the specific problem areas cannot help but contribute to progress. It appears that one of the most significant deficiencies in methods that employ a homogeneous model in treating non-thermal groups is a large error in the treatment of fast fission. The defect in reactivity is about 4 percent for the lattices considered. This can be partially corrected by means of a diffusion theory cell calculation, but transport theory is needed in order to obtain good results. Another deficiency is encountered in methods that homogenize the fuel and moderator in the calculation of the thermal neutron spectrum. It was found that some of the homogenizing methods examined introduced in some cases errors of more than 2 percent in calculated reactivities. This error is of opposite sign to that of fast fission. Shortcomings in the treatment of resonance capture and fission were not found to contribute large errors in the lattices studied. This is reasonable because all of these lattices are well thermalized. Reactivity values obtained with a flux-weighted, multigroup procedure are in good agreement with measurements. (auth)

8602 (ORNL-3691(p.89-98)) REACTIVITY EFFECTS OF SMALL FUEL DISPLACEMENTS FOR PLATE-TYPE REACTORS. E. G. Silver and S. B. Johnson (Oak Ridge National Lab., Tenn.).

A slab-geometry plate-type critical experiment was constructed to measure the reactivity effects of small perturbations introduced by fuel-element displacements. These perturbations were calculated by both diffusion-theory and transport-theory codes, with careful attention to sources of error in the calculation model, in order to test the relative abilities of the two calculation methods to predict the magnitude of such perturbations. The transport-theory results were in rather good agreement with the experiment, whereas the diffusion theory was far less accurate in its predictions. (auth)

8603 (WCAP-3269-25) CALCULATION OF LATTICE PARAMETERS AND CRITICALITY FOR UNIFORM WATER MODERATED LATTICES. L. E. Strawbridge (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 1963. Contract AT(30-1)-3269. 57p. Dep.(mn); $2.00(cy), 2(mn) OTS.

A method of calculating criticality is described. The entire method has been programmed in the LEOPARD code. The method has the features described below. The loop model is eliminated in which the U-238 absorption was divided into two parts with the assumption that all U-235 epithermal fissions occurred at the breakpoint. Two empirical constants were used to describe the split in U-238 absorption and fast leakage. These constants are no longer necessary. A more general U-238 resonance integral correlation is introduced that is applicable to both uranium metal and uranium dioxide and that inherently includes the temperature effect. Thermal calculations are included in which modified Amouyal-Benoist disadvantage factors are calculated at every SOFOCATE energy level. A heterogeneous fast fission effect is introduced to replace the homogeneous calculation. In evaluating each change to the calculational procedure, the neutron multiplication factor (K) was calculated for 49 critical experiments using UO_2 fuel, and, in some cases, 20 exponential experiments using uranium metal fuel. The experiments cover a wide range of parameters and represent a severe test of any calculational procedure. The proposed calculations represent an improvement over previous methods as evidenced by a reduction in the standard deviation about the mean for several groups of experiments of particular interest in the design of pressurized water reactors. For example, the standard deviation of 10 experiments performed at Westinghouse Atomic Power Division using steel-clad UO_2 rods was reduced from 0.71 to 0.32%. The proposed method was found to agree with a more rigorous calculation which requires approximately 50 times as much computer time. (auth)

8604 TEMPERATURE COEFFICIENT OF NEUTRON MULTIPLICATION FACTOR. Kazuhiko Inoue (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 290-7(Nov. 1964).

The temperature coefficient of the neutron multiplication factor in an infinite homogeneous medium is calculated. Both temperature-dependent and temperature-independent absorption and fission cross sections are considered. Two expressions for the temperature coefficient are obtained. The results of numerical calculations with the exact formula derived are compared with those based on the Maxwellian distribution model. (D.C.W.)

8605 A STUDY OF THE SPACE AND ENERGY DEPENDENT REACTOR KINETICS, WITH DIRECT PHYSICAL INTERPRETATION OF THE EFFECTIVE NEUTRON LIFETIME AND CRITICALITY FACTOR. Hiroshi Nishihara and Seiji Ukai. Mem. Fac. Eng. Kyoto Univ., 25: 264-72(Sept. 1963).

The concept of neutron importance is introduced. It is assumed that each of the neutrons produced by fission in a chain reactor possesses an importance proportional to the number of its descendants. On the basis of the law of conservation, a transport equation of the neutron importance is derived. Then, the effective neutron lifetime is defined as the mean interval of successive fission events in the course of the important transport. The consistent definition of the criticality factor is the neutron multiplicity during the effective neutron lifetime so defined. After defining the basic reactor kinetics parameters, such as the effective neutron lifetime and criticality factor, the persistent time behavior of nuclear chain reactors was investigated. The kernel form reactor equation is used because of its physical intelligibility. The formulas obtained are applicable to any reactor, provided that the neutron flux and its adjoint function is known either analytically or numerically. (auth)

8606 A NOTE ON THE ANALYSIS OF PULSED NEUTRON SHUTDOWN MEASUREMENTS. S. K. Wallace (Rolls-Royce and Associates, Ltd., Derby, Eng.). Nucl. Sci. Eng., 21: 116-19(Jan. 1965).

An analysis is presented showing that pulsed neutron shutdown measurements made in cores which can be considered as effectively uniform and unreflected can be analyzed by the Garelis and Russell method under certain restrictions. (D.C.W.)

8607 COMPARISON OF CRITICAL AND SUBCRITICAL ρ^{28} MEASUREMENTS. J. M. Doederlein (Institutt for Atomenergi, Kjeller, Norway), J. A. Thomassen, and T. H. Johansen. Nucl. Sci. Eng., 21: 122-4(Jan. 1965).

The ratio of epicadmium to subcadmium ^{238}U absorptions was measured in critical and subcritical facilities using UO_2 (3% enriched) fuel and D_2O moderator. Both bare and reflected subcritical assemblies were studied. The results

were compared with each other and with theoretical values. (D.C.W.)

8608 USE OF DEPLETED URANIUM IN THERMAL REACTORS WITH SLIGHTLY ENRICHED FUEL TO ACHIEVE HIGH NEUTRON ECONOMY AND BURNUP. Haig P. Iskenderian. 8p. (CONF-446-59)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Studies were conducted using a tightly packed core with a H_2O/UO_2 ratio of 1.29. A description of the core is given along with discussions of methods used in reactivity, burnup, and cross-section calculations. (J.R.D.)

Design and Feasibility

8609 THERMAL ANALYSIS FOR GAS COOLED REACTOR PRELIMINARY DESIGN. Lawrence A. Kimura (Aerojet General Nucleonics, San Ramon, Calif.). 14p. (CONF-446-63).

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

It is noted that thermal analysis is the link between the nuclear and cycle analysis in the design of nuclear power plants. Equations for use in thermal analyses are presented that express the core size as a function of coolant state points and core axial and radial power distribution. The coolant state points are determined from system cycle analysis and the core power distributions are determined from nuclear analysis. The analysis method is written in FORTRAN for use on the IBM 7090 computer. (J.R.D.)

8610 METHODS OF DESIGNING COMPACT, GAS-COOLED REACTORS TO ACCOMMODATE FLOODING. Frank J. Thomas (Aerojet-General Nucleonics, San Ramon, Calif.). 13p. (CONF-446-66)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Design features to provide decreased reactivity in gas-cooled reactors upon flooding, including spectral shift control, flux traps, change in disadvantage factor, and leakage reduction were analyzed. It was concluded that the safety criteria for flooding control need not restrict adaptability to maritime or mobile applications. (J.R.D.)

8611 IMPROVEMENTS IN LIQUID FUEL HOMOGENEOUS NUCLEAR REACTORS. Johann Friedl (to Babcock and Wilcox Ltd.). British Patent 971,256. Sept. 30, 1964. Filed Sept. 2, 1960.

A liquid-fuel homogeneous nuclear reactor has a lower reactor chamber of supercritical capacity with regard to the liquid fuel. An outlet for vapor in the upper part of the chamber leads through a control valve into a heat exchanger. Condensed vapor from the heat exchanger is returned to the reactor chamber through an inlet near the bottom of the chamber. Spaces in the heat exchanger and all other spaces receiving liquid fuel other than the reactor chamber are arranged to be of subcritical capacity. Neutron absorbing material may be used to accomplish this. The control valve may be arranged to open and close automatically at predetermined pressures. (A.G.W.)

8612 IMPROVEMENTS IN OR RELATING TO A DIFFERENTIAL AMPLIFIER. (to Babcock and Wilcox Co.). British Patent 971,300. Sept. 30, 1964. Priority date July 31, 1962, United States.

A design for a compact reactor plant combines within a single vessel the fission reaction, the means for exchanging heat between the primary and the secondary coolants, the means for pressurizing the primary coolant, and the means for separating the vapor-liquid mixture or the secondary coolant. An upright wall encircles the reactor core within the pressure vessel. Vapor-generating tubes through which secondary coolant may flow are disposed in a first space between the wall and the pressure vessel. Passages are provided through which primary coolant may pass from the reactor core into the first space into heat exchanging relation with the vapor-generating tubes and return to the reactor core. Vapor-liquid separating means are disposed in a second space between the wall and the pressure vessel and above the first space. Means are provided for leading fluid heated in the vapor-generating tubes to the separating means. Superheater tubes may be provided in the same pressure vessel. (A.G.W.)

8613 IMPROVEMENTS IN NUCLEAR REACTORS. Thomas Deighton (to Babcock and Wilcox Ltd.). British Patent 971,423. Sept. 30, 1964. Filed Sept. 28, 1962.

In the liquid-cooled and liquid-moderated reactor described, the liquid is contained in a reactor pressure vessel under pressure together with nuclear fuel elements, heat exchanger banks, and circulating pumps. The nuclear fuel elements are positioned within a vessel arranged to retain a body of liquid in which the nuclear fuel elements are submerged when the remainder of the reactor vessel is drained. The fuel-containing vessel is withdrawable from the reactor vessel together with the fuel elements and it is adapted to maintain a head of liquid covering the fuel elements when withdrawn. The circulating pumps are positioned at the base of the reactor vessel and are removable through ducts extending through the reactor vessel base. The heat exchanger is arranged in banks in the annular space between the wall of the reactor vessel and the wall of the fuel-containing vessel. The secondary coolant connections are in the side wall of the reactor vessel rather than on the lid. (A.G.W.)

8614 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS USING AN ORGANIC FLUID AS A MODERATOR AND AS A REFRIGERANT. Gabriel de Gaudemaris (to Commissariat à l'Energie Atomique). British Patent 971,707. Oct. 7, 1964. Priority date Sept. 21, 1960, France.

Superheated steam at a high temperature may be obtained from the heterogeneous nuclear reactor described, which uses an organic substance as neutron moderator and as coolant. The moderator-coolant liquid is a hydrocarbon characterized by a high Factor G, a boiling point higher than 200°C and preferably 300°C, and a small resistance to radiation. Means are provided for circulating the hydrocarbon through the reactor core and through a heat exchanger where the cold liquid therein is vaporized. A portion of the irradiated hydrocarbon is continually drawn off and used as fuel in a furnace for superheating the vapor formed in the cold circuit of the heat exchanger. Fresh hydrocarbon continually replaces that withdrawn. By regulating the rate of feed of the hydrocarbons as a function of their speed of decomposition, a limited content of decomposition products in the moderator liquid is maintained. (A.G.W.)

Fuels

8615 (GEAP-3771-14) HIGH-PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report 14, July–September 1964. M. F. Lyons and B. Weidenbaum, eds. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 15, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 76p. (EURAEC-1236) Dep.(mn); $3.00(cy), 2(mn) OTS.

Irradiations were conducted in the GETR Pressurized Water Loop. The successful operation of the EX-12A Assembly has demonstrated there is no intrinsic fuel rod life limitation while operating with gross central melting up to average burnups of 20,000 Mwd/te. Burnup accrued during the last five cycles has exceeded expectations and is attributable to improved GETR operating efficiency. The loop irradiation will terminate at the end of GETR cycle 58 with the major program objectives accomplished. The failure zone of Rod 12C, the second pellet rod with a pinhole-type failure, was analyzed using x-ray diffraction and electron microprobe techniques without detecting any unusual element that would account for the attack. The failure in powder Rod 12DV appears related to fabrication. Considerable evidence was obtained that Rod 12CV in the EPW-12V Assembly failed during irradiation. An unusually large, spherical metallic inclusion was observed in the

resolidified UO_2 of Rod 12DV. The EPW-12V Assembly fuel rods all showed activity spikes in the gamma scan very close to the bottom end plugs; the spikes were tentatively identified as Ru-103 activity. An examination in the RML located the electrical short that terminated the first capsule irradiation; the short was in the connecting lead and is not a basic problem. Definite melting of the rhenium gas bulb occurred, confirming much higher center temperature than those actually measured. A second, improved gas bulb pressure transducer was fabricated, calibrated out-of-pile, and incorporated into a pellet capsule. The irradiation-produced physical property changes in Inconel, Incoloy, and Zircaloy-2 at an nvt of 1.2×10^{21} were determined. GE-218 tungsten was shown experimentally to be suitable for use as the container in the rare gas solubility experiment. Several potential cladding alloys with high nickel contents were shown to be not susceptible to iodine-induced stress corrosion at conditions that produced cracking of Zircaloy-2. A modified apparatus to allow testing of stressed wire samples rather than tubing sections was put into operation. Both fission product iodine and cesium were shown experimentally to be non-uniformly distributed axially on the clad of an irradiated fuel rod; the maximum concentration occurs near the top of the rod. The measured concentrations of both iodine and cesium deposited on the cladding represents approximately 30% of the total fuel rod inventory of these elements. (N.W.R.)

8616 (GEAP-4725) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Sixteenth Progress Report, July–October 1964. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 15, 1964. Contract AT(04-3)-189. 46p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Terminal examination of both the Zircaloy- and stainless-steel-clad basic fuel is essentially complete. Isotopic analysis, fractography, burst test, and oxide film thickness data are reported. A variation in Zircaloy oxide film thickness with vertical location was noted. The corrosion film at the upper gas plenum is much lower than at positions having heat transfer. Examination of lower end plugs from deflected and nondeflected Zircaloy fuel rods confirms the hypothesis that end plug corrosion results from water leakage into the fuel rod. Analysis of 6L end plug material confirms that extensive oxidation and hydriding had occurred. Ultrasonic examination of 20 percent of the stainless-steel-clad fuel confirms previous results on frequency and orientation of clad cracking for cold-worked and annealed stainless steel. Terminal examinations of the special fuel are essentially complete, except for analysis of boron in the UO_2 from burnable poison assembly 12L. (D.L.C.)

8617 (GEAP-4729) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATOR REACTORS FOURTEENTH QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1964. M. A. Robkin (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 13p. (EURAEC-1264). Dep.(mn); $1.00(cy), 1(mn) OTS.

Data are being collected to establish a theoretical model for predicting long-term changes in isotopic composition and reactivity in Pu-enriched, light-water-moderated reactors. Project fuel pins irradiated up to 5300 Mwd/t have been analyzed for isotopic composition. The VBWR resonance activation ratios show a constant spectrum. The EPITHERMØS code was used to analyze the PCTR experiment in which the resonance integral of ^{240}Pu was measured. Burnup calculations for the project fuel are given. Absorption in low-energy resonances is discussed. (D.L.C.)

8618 (HW-78153) AlSi FUEL ENRICHMENT TESTER—ERT-1. C. N. Jackson, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 9, 1963. Contract AT(45-1)-1350. 16p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The ERT-1 tester is a gamma spectrometer that can nondestructively test the enrichment of AlSi fuel elements. It can separate normal and low level enriched fuel (0.95% ^{235}U), bare or clad, on a go–no-go basis for nuclear safety considerations. Each fuel element requires a two-minute test period after daily set up and calibration time of 30 minutes. Fifteen of the fuel element styles use the same two calibration standards; the remaining large diameter C VI type and the short four-inch OVN type each requires a special size standard. The tester consists of a NaI crystal scintillator, a single channel analyzer, and visual readout equipment. It basically operates off the 185 kev gamma photo peak from ^{235}U whose activity is proportional to the amount of enrichment. An innovation consisting of the difference between the activity of the ^{235}U photo peak and the activity of a slightly higher energy gamma was utilized to measure the enrichment because it is independent of the daughter build up problem. The statistical error of the two-minute count and other errors are such that the count rate accuracy during the course of a day's testing is ±7 percent. By using longer counting times and a single count technique it is possible to approach a ±0.5 accuracy. Thus the instrument has growth potential for applications requiring greater accuracy. The equipment is compact and movable so that it can be set up in any desired location in the factory. The analyzer, counter, and timer circuits are transistorized and use printed circuit construction which ensure reliability and efficient operation. (auth)

8619 (NAA-SR-Memo-9945) CRITICALITY STUDY, 20 w/o U–Zr ALLOY FUEL. N. Ketzlach and V. Warner (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 22, 1964. Contract [AT(11-1)-Gen-8]. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Maximum safe batch sizes have been determined for all process steps involved in the fabrication, storage, and shipment of 20 w/o U–Zr alloy fuels. Criteria for compacts, unhydrided rods, and hydrided rods are presented. Formulas are presented for the determination of an equivalent rod diameter, so that criticality data developed for long rods can be used in establishing nuclear safety criteria for fuel rods of any length. Although only two of the four-inch diameter billets are safe irrespective of spacing and degree of water flooding (compared with four of the corresponding 10 w/o U–Zr billets), criteria are presented for the safe transport of much larger numbers of billets as well as the heating (prior to the extrusion process) of as many as four billets in a single furnace. (auth)

8620 (ORNL-3691(p.3-16)) RELEASE AND TRANSPORT OF UO_2 FISSION PRODUCTS IN THE CONFINEMENT MOCKUP FACILITY. G. W. Parker, R. A. Lorenz, G. E. Creek, J. G. Wilhelm, W. J. Martin, and C. J. Barton (Oak Ridge National Lab., Tenn.).

Two experiments were conducted in which trace-level-irradiated stainless-steel-clad UO_2 specimens were melted in ambient air. In one experiment, part of the air in the component tank was unfiltered, while in the other all the air passed through an absolute filter and a charcoal bed. The fraction of released I_2 in a form that can penetrate charcoal beds was greater by a factor of 10 in the experiment in which some unfiltered air was present. Deposition of fission product activity in these experiments was found to be unaffected by agglomeration of particles, and a significant fraction of the released I_2 remained airborne for a period of several hours. Approximately equal proportions of the airborne I_2 were in particulate and molecular form. Only one experiment on release and transport of fission products from highly irradiated UO_2 (7000 Mwd/ton) was conducted. Release of fission products from the melted specimen was not markedly different from results obtained with trace-level-irradiated UO_2 except in the case of Te, which increased from 12 to 55%. Release values for Pu and Sr were about the same as the fraction of the UO_2 that volatilized (0.005%). Rapid deposition of fission products occurred in the confinement tank during the first few minutes after the UO_2 melted. The fraction of the airborne I_2 inventory dropped from 0.91 to about 0.10, Te dropped from 0.53 to 0.07, and Cs dropped from 0.30 to 0.19. A large part of the deposited I_2 was desorbed

by passage of 1.5 tank volumes of Ar through the confinement tank after a 3-hr aging period. Condensation nuclei in the tank dropped from a concentration of 10^7/cc to 10^5/cc during the period 10 to 25 min after melting and then more slowly to 10^4/cc, but no significant change in airborne filterable activity was noted. An experiment was conducted to study I_2 behavior in the absence of vaporized fuel particles and other fission products for comparison with British experiments on plate-out of I_2 in the Pluto and Dido reactor containment shells. Elemental ^{131}I with added carrier I_2 was vaporized and transferred into the confinement tank filled with air at a pressure of 15 psig. Most of the airborne iodine was deposited during the first few minutes of the 4-hr aerosol aging period. Depressurization of the tank from 15 to 2.5 psig removed only 3% of the I_2 while passage of 2¾ tank volumes of Ar through the tank removed 7%; an additional 3% was removed by sweeping the tank with an equal quantity of air. In general, the I_2 behavior in this experiment agreed with the results of British experiments, although there were unavoidable differences in some of the experimental conditions such as wall material and surface-to-volume ratio. It seems clear that the results of experiments on I_2 behavior performed by vaporizing I_2 will not accurately predict the behavior of fission product I_2 released by melting irradiated UO_2 fuel. Desorption of I_2 in the stainless steel confinement tank was much higher in the latter case for reasons that are not clear at the present. (auth)

8621 (ORNL-3691(p.16-28)) RELEASE OF FISSION PRODUCTS ON IN-PILE MELTING OF REACTOR FUELS UNDER TRANSIENT REACTOR CONDITIONS. G. W. Parker, C. E. Miller, Jr., R. A. Lorenz, and J. G. Wilhelm (Oak Ridge National Lab., Tenn.).

Two experiments were performed in the TREAT reactor which gave data on the release of fission products and fuel material from stainless-steel-clad UO_2 in air-steam atmospheres. Prior to the experiments the specimens were irradiated to tracer level (about 2×10^{16} fissions for each specimen). The transient irradiation in the TREAT reactor amounted to about 1.3×10^{19} fissions, with a reactor integrated power of approximately 370 Mwsec and with a reactor period of approximately 75 msec. These experiments simulated transient accidents with reactors containing aged fission products in the presence of an oxidizing air-steam atmosphere. Physical examination of the transient-heated specimens revealed that the stainless steel cladding melted completely and that approximately 75% of the UO_2 melted. The results indicate that no large effects on fuel appearance or on fractional release and behavior of fission products can be ascribed to the presence of oxidizing steam-air mixtures in the range studied (3 to 50 vol %) as compared with an inert atmosphere. (auth)

8622 (ORNL-3691(p.29-46)) BEHAVIOR OF FISSION PRODUCTS RELEASED DURING IN-PILE DESTRUCTION OF REACTOR FUELS. W. E. Browning, Jr., C. E. Miller, Jr., R. P. Shields, and B. F. Roberts (Oak Ridge National Lab., Tenn.).

Studies of the characteristics and behavior of fission products were continued by melting or vaporizing miniature stainless-steel-clad UO_2 fuel elements in the ORR in various atmospheres. The effects of moist He and of moist air on the behavior of released fission products were observed as well as the effects of sustained overheating in moist air. Results of an experiment using moist He compared with corresponding results obtained using dry He, with environmental conditions approximately equivalent in both cases, revealed that moisture caused the stainless steel cladding to become partially oxidized; consequently, very little metallic stainless steel condensate could be found after the experiment. Otherwise the presence of moisture in the He atmosphere seems to have had no substantial effect on the release of fission products from the fuel itself. However, the release of I_2 and of Te from the high-temperature zone was increased in moist He and that of Ru was decreased. Radiochemical results revealed that the air atmosphere had no appreciable effect on the release of nonvolatile or volatile fission products from the fuel itself but that the releases of I_2, Te, and Cs from the high-temperature zone appeared to be enhanced. In the course of an experiment which was intended to study the effects of sustained overheating in moist air, it was discovered that the UO_2 melted at an apparently considerably lower temperature than its normal melting point. This effect was ascribed to the melting-point depression brought about by the incorporation into the UO_2 of oxides of the cladding material. The fuel in this experiment was not previously irradiated; so the effects of short-lived precursors on fission product behavior could be seen. The fractional release of I_2 and Te (which have nonvolatile precursors) from the fuel was lower than the corresponding release from preirradiated specimens, while the effects of Xe and Kr precursors could be observed in the higher fractional release of Cs, Sr, and Ba. Supplementary equipment and modifications were developed for in-pile melting of stainless-steel-clad UO_2 in a high-concentration steam atmosphere. Modifications of the present equipment allow controlled steam injection to prevent premature condensation and provide for condensation of the steam outside the high-temperature zone. With these modifications, experiments can now be performed in air-steam mixtures up to 90% relative humidity and a total pressure of 1 atm. One in-pile experiment was conducted in which a stainless-steel-clad fuel element was melted in a high-concentration steam atmosphere with a small amount of air. The effectiveness of the components of the gas-cleaning system for retaining fission products was estimated by examining radiochemical data from materials plated on various portions of the in-pile system during all previous experiments. The results show that considerable amounts of I_2, Te, and Cs deposit in the diffusion tubes and that additional quantities of I_2 deposit on the cool metal surface of the reactor furnace. Estimates of the upper limit of the amounts of fission products penetrating the filters and adsorber were also obtained. Greater usefulness and flexibility of the off-gas analysis equipment were obtained by recent modifications. The off-gases being studied were passed from the in-pile meltdown furnace through the filters and the charcoal trap. The modified unit permits monitoring of the radioactivity of the gas during operation, collection of rare gases in a refrigerated charcoal trap, transfer of the collected gases into an evacuated tank by heating the charcoal trap, and collection of gaseous samples in biological serum bottles. (auth)

8623 RELOCATION OF FISSION PRODUCTS AND Pu IN IRRADIATED UO_2 PELLET. Noboru Oi (Tokyo Shibaura Electric Co., Ltd.), Tadao Ohno, and Keiji Naito. J. Nucl. Sci. Technol. (Tokyo), 1: 284-9(Nov. 1964).

The distribution of fission products (^{144}Ce, ^{106}Ru, ^{137}Cs, $^{95}Zr-^{95}Nb$ and ^{85}Kr) and Pu was studied in UO_2 pellets which were irradiated at high temperature (~3,000°C). Two capsules, each containing six natural uranium UO_2 pellets were irradiated at 0.05 and 0.10% burnup, respectively. The UO_2 pellets were completely fused into a single rod, and a big void was formed along the length of the rod as a result of the high temperature. Analysis was made by direct gamma-scanning along the length and across sections of the rods, as well as by samples scraped off from the rods. Pu and Ru were found to be distributed fairly regularly, while Cs was markedly concentrated at both ends of the rod where the temperature was lower than the middle part. Zr–Nb was found to be concentrated in the inner portions which were the hottest parts. About 2% of the ^{85}Kr remained in a sample of 0.05% burnup, although only a trace amount remained in that at 0.1% burnup. The distribution of gamma-activity along the length of the rods was quite irregular, having wide depleted sections, which might be explained by the exposure to high temperature. (auth)

8624 DISTANCE HOLDING DEVICE FOR NUCLEAR REACTORS. Lambert Frank Kooistra (to Babcock and Wilcox Co.). German Patent 1,174,434. July 23, 1964. Priority date Oct. 30, 1958, [United States].

Fuel rods are arranged at a distance in parallel to each

other by a holding device, which consists of spiral springs arranged in parallel to and between the succeeding rods. The continuity of these spiral springs is interrupted in the axial direction by interstitial straight portions. (Gmelin Inst.)

8625 NUCLEAR FUEL ELEMENT WITH BURNABLE POISON. John Frederick Mumm (to Babcock and Wilcox Co.). German Patent 1,176,766. Aug. 27, 1964. Priority date Dec. 2, 1958, United States.

The fuel element is made up of oxide fuel contained within a sheath formed from metal with a burnable poison homogeneously distributed throughout it. One advantage obtained by adding the burnable poison to the sheath is that a homogeneous mixture of the burnable poison and the sheathing material can be obtained more easily than a homogeneous mixture of the appropriate portions of the burnable poison and the oxides forming the fuel. (Gmelin Inst.)

8626 METHOD OF PRODUCING FUEL ELEMENTS FOR NUCLEAR REACTORS. Heinz Stehle (to Siemens-Schuckertwerke AG). German Patent 1,179,310. Oct. 8, 1964. Filed Mar. 5, 1960.

A method is described for producing tubular fuel elements consisting of concentrically and coaxially arranged tubes. The exact diameter of the tubes surrounding each other concentrically is calibrated by noncutting shaping; e.g., by calibrating the inner sheath of the respective tubes with the help of a mandrel. The diameter of this mandrel is wider than the outer diameter of the neighboring smaller tube by the double width of the annular cooling channel. (Gmelin Inst.)

Power and Power-Breeder Reactors

Refer also to abstract 7861.

8627 (APDA-125) POWER SURGES IN A POOL OF MOLTEN CORE MATERIAL. B. W. Downs and H. A. Bethe (Atomic Power Development Associates, Inc., Detroit). June 15, 1958. 36p.

Power generation in a pool of molten core material is discussed, assuming that reactivity is continuously added after the pool has reached prompt critical. Specific calculations are given for reactivity insertion rates of $10/second and $20/second. The acoustic approximation used is not justified for high insertion rates; for $10/second it is expected to be good, but the upper bound of the reliability is expected to be about $20/second. The analysis of the power generation is broken up into several stages. In each of these stages the appropriate differential equations are solved analytically with certain approximations. These approximations are either justified or their effects compensated subsequently. (auth)

8628 (CEA-R-2459) ETUDE DES CONSEQUENCES DE LA RUPTURE D'UN TUBE DE FORCE DANS LA CUVE D'UN REACTEUR MODERE A L'EAU LOURDE ET REFROIDI AU GAZ. (Study of the Consequences of the Rupture of a Support Tube in the Pressure-Vessel of a Gas-Cooled, Heavy-Water Moderated Reactor). Fernand Hareux, Roland Roche, and Bernard Vrillon (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). Oct. 1964. 70p. Dep.(mn).

The bursting of a support tube in the vessel of a power reactor moderated by heavy water and cooled by pressurized gas is studied experimentally in connection with EL 4. Since a full-scale model showed that the bursting of a tube did not cause its neighbors to do likewise, tests were carried out on the strength of the vessel using very small scale models (1/10). It was found that the vessel could withstand the bursting of several tubes without significant deformations. The transient pressure in the vessel has the form of a damped oscillation whose maximum (peak pressure) has been the subject of a detailed experimental study. It appears that the essential parameters affecting this pressure are: the gas pressure inside the tube; the volume of gas causing the bursting; the suppleness of the vessel; the mass of air contained in the vessel; and the nature of the exploding gas. A general method for estimating the pressure peaks in reactor vessels has been developed by application of the experimental results. (auth)

8629 (COO-651-4) ELK RIVER REACTOR. Monthly Operating Report No. 23, September 1964. (Rural Cooperative Power Assn., Elk River, Minn.). Contract AT(11-1)-651. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The reactor was operated 74.3% of the month. On September 8 the reactor was brought critical after being shut down for 23 days for the installation of the #3 air conditioning unit and testing of the fuel element storage well liner. On September 8 primary pressure was maintained by nuclear heat during leak checking of the primary system and on September 9 the turbine was transferred from #3 boiler to the nuclear plant. The peak load during the month was 24 Mw(e). There were two 4-rod scrams during the month: one September 18, caused by a superheater trip; and one September 30, caused by a spurious trip on the reactor water low temperature interlock. In both cases the circuits were cleared of the problem and the nuclear plant returned to service in a minimum of time. The off-gas system was operated during the month to check the efficiency of the recombiner. Preparations are being made for the control rod inspection program. Control rod specimens and reactor pressure vessel samples will be removed at this outage and metallurgically tested. The fuel element storage well liner was repaired and was filled with water. The superheater desuperheater controls were calibrated and placed in the automatic mode of operation. (auth)

8630 (COO-651-5) ELK RIVER REACTOR. Monthly Operating Report No. 24, October 1964. (Rural Cooperative Power Assn., Elk River, Minn.). Contract AT(11-1)-651. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The reactor operated 9.1% of the month. On October 3 the nuclear plant was shut down for a scheduled outage and the turbine transferred to #3 boiler. The plant was down for the remainder of the month except for cold critical tests on October 28. During the outage, the control rod inspection procedures were finalized and approved. The critical rod position for the 13-rod bank was 8.998 inches, indicating a decrease in reactivity of 22 cents since the startup on August 4, 1964. Shutdown margin determinations were made with a 12-rod bank and each of the rods fully withdrawn. Two fuel elements were transferred into the storage well from the reactor at the end of the month. The month of November is scheduled for reactor shutdown to complete the inspection, reload fuel and reassemble all reactor internals and appurtenances. (auth)

8631 (DLCS-3410122) REACTOR PLANT EXTERNAL RADIATION LEVELS. CORE 1, SEED 4. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First issue, May 29, 1964, Second issue, Aug. 25, 1964. Contract AT(11-1)-292. 23p. Dep.(mn); $2.00(cy), 1(mn) OTS.

In order to measure the buildup of corrosion product activity and to determine the magnitude of the radiation in the vicinity of the Reactor Coolant System, reactor plant external radiation levels were observed at preselected locations during several shutdown periods of Core 1, Seed 4 life. This evaluation presents an analysis of the reactor plant external radiation levels from the end of Core 1, Seed 3 life to the end of Core 1, Seed 4 life with regard to reactor plant operating status. The external radiation levels show that crud re-distribution to the reactor coolant loops occurred due to reactor plant operations in the period from the end of Core 1, Seed 3 critical operations to the beginning of Core 1, Seed 4 critical operations. The reactor coolant loops and purification loops continued to buildup in corrosion product activity during Core 1, Seed 4 operations with accumulation of effective full power hours. The external radiation levels also show a continual increase in the purification loop demineralizers with constant crud redistribution within the demineralizers. The crud buildup in the reactor vessel head components was continually effected by the amount of control rod motion during specific periods of Core 1, Seed 4 operations. (auth)

8632 (DLCS-3990312) FEDAL SYSTEM, CORE 1, SEED 4. Test Evaluation. (Duquesne Light Co., Shippingport, Penna.). First Issue, May 29, 1964. Second Issue, Aug. 28, 1964. Contract AT(11-1)-292. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The FEDAL system at Shippingport was designed to detect and locate failed elements in the reactor core. It has also been used to indicate suspected defects which exist in Zircaloy cladding of the blanket elements. The FEDAL system monitors a coolant sample from each blanket assembly. Contained in the sample are fission products, two of which are iodine-137 and bromine-87. These two fission products are delayed neutron emitters. Iodine-137 has a half life of 22 seconds, and bromine-87 a half life of 54 seconds. Thus using a transit time of approximately 50 seconds from the exit of the blanket assembly to the FEDAL monitors, the activity contribution from these two nuclides can be determined. Periodically, throughout core life, the system is checked to insure that it is in proper operating condition. Then, when the reactor is operating under steady state conditions, the delayed neutron activity of each assembly is obtained during extended periods of rated power operation. The data are used to determine the ratio of the delayed neutron activity of each blanket assembly to the average delayed neutron activity of all assemblies. These ratios are then used as a basis of choosing which blanket assemblies are to be checked during a plant start-up. It is believed that when the reactor is shut down, if an element has a cladding defect, water seeps into the fuel through the defect. Then, when power is increased, the temperature increases, converting the water in the fuel to steam. The transformation to steam produces a pressure build-up and the steam forces its way out of the defect carrying fission products with it. Therefore, if an element with a cladding defect is monitored and the defect is of sufficient size a burst of activity is recorded by the FEDAL monitor during a plant start-up. During Core 1, Seed 4 both monitors performed satisfactorily, although Monitor 1 displayed decreasing sensitivity throughout seed life which Monitor 2 did not. No ratios were calculated from the data obtained during steady state operation that were of sufficient magnitude to indicate a suspect failed element. A total of 54 blankets was monitored during station start-ups. Three blanket assemblies gave indication of cladding defects.(auth)

8633 (DP-935) HEAVY WATER MODERATED POWER REACTORS PROGRESS REPORT, SEPTEMBER–OCTOBER 1964. R. R. Hood, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1964. Contract AT(07-2)-1. 22p. Dep.; $2.00(OTS).

The Heavy Water Components Test Reactor (HWCTR) wa operated at 50 Mw for about 85% of September and October for fuel irradiation tests. At the end of October, the reactor was shut down for removal of poison tubes from the driver fuel assemblies. The removal of the poison tubes will prolong the reactivity lifetime of the drivers. The neutron flux peaks that occur at fuel gaps when a column of short fuel pieces is irradiated were measured for three types of HWCTR fuel assemblies in an exponential facility. Further examination of a tube of unalloyed uranium irradiated to 6830 Mwd/MTU in the HWCTR confirmed earlier indications of severe buckling of the inside surface of the tube. (auth)

8634 (EUR-1816.e) RESEARCH ON WEAR IN REACTOR CORE MATERIALS. M. Montagnani and P. S. Weltevreden (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft). 1964. 19p. (CONF-425-5). Dep.(mn).

From Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963.

The wear research on SAP described is part of the design study for the ORGEL reactor. Before describing the wear research itself a concise description is given of the reactor concept. From this description follows the background and the necessity of the wear study. After specification of the experimental conditions, a description is given of the wear machine, specially constructed for this study. In this machine, the operating conditions of a pressure tube are represented as close as possible. Frequency, amplitude, and contact force are continuously checked. To obtain reference values, the combinations SAP/SAP, steel/steel, and SAP/steel were studied. The low wear resistance of SAP required a general screening to find a material showing little wear against SAP, meanwhile giving no damage at all to the SAP. This screening resulted in the selection of a few materials showing the requested properties; application of these materials as protecting materials on contact places is discussed. (auth)

8635 (HPR-38) TEMPERATURE REACTIVITY EFFECTS IN THE HBWR SECOND FUEL CHARGE. J. E. Lunde and O. Oeye (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Sept. 1964. 34p. Dep. (mn).

Temperature and water level reactivity coefficients as well as the critical water level were measured for HBWR with its second fuel charge, consisting of uranium oxide enriched to 1.5%. The measurements were performed at 50 to 225°C. The measurements were compared with theoretical calculations on the basis of two-group theory. The agreement is fair for the water level and the uniform temperature reactivity coefficients, although in an intermediate temperature range up to 15% too large negative values for the temperature reactivity coefficient are predicted. The critical water level is overestimated by theory corresponding to an underestimate of excess reactivity of 660 pcm at 50°C and 1300 pcm at 220°C. (auth)

8636 (NAA-SR-9213(Vol.II)) 1000-MWE SGR AND PROTOTYPE EVALUATION STUDY. VOLUME 2. 200-MWE SGR PROTOTYPE PRELIMINARY DESIGN. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1963. Contract AT-11-1-GEN-8. 391p. Dep.(mn); $7.00(cy), 6(mn) OTS.

The preliminary design of a 200-Mwe prototype plant of an advanced 1000-Mwe sodium graphite reactor power station is presented. The prototype is the next logical step in the progression to larger plants of this type. The plant incorporates many features of SGR power stations in the range 500 to 1500 Mwe. The purpose of the prototype is to demonstrate the present capability to design, construct, and operate a large SGR of improved design and performance characteristics and to provide operating experience with components required for later SGR plants with higher capacity and more advanced performance capabilities. (auth)

8637 (NAA-SR-9213(Suppl.)) 1000-Mwe SGR AND PROTOTYPE EVALUATION STUDY. Supplement. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 1964. Contract AT(11-1)-Gen-8. 21p. Dep.(mn): $1.00(cy), 1(mn) OTS.

The reduction in capital costs, which will result from experience gained in construction of a family of plants that are built in fairly prompt succession, is shown. Direct construction-cost reductions in the reactor plant equipment are expected after the first or second plant, through redesign, simplification, and fabrication experience. In addition to lower capital costs, improvements in fuel cycle economics are expected through greater use of zirconium alloys. Both uranium and thorium fuel cycles are evaluated. The thorium design exploits the capability of the SGR to use alternate fuels. The analysis indicates that cost reductions from the first plant are readily possible, resulting in a total capital cost of $127,496,000 or $125/net kwe for an investor-owned utility and $123,366,000 or $121/net kwe for a municipally owned utility. This includes direct and indirect plant costs, costs for land and rights, and interest during construction. The power generation costs and fuel cycle costs under the present government fuel ownership conditions and under future private ownership conditions are given. In all cases the fuel rod is vented to avoid internal pressure buildup and to permit the use of zirconium alloys at operating temperature. These studies indicate that there is considerable incentive to develop zirconium alloys for high temperature sodium service and that ThO_2–UO_2 fuel can be used in the SGR as an economically attractive alternate to UC. (auth)

8638 (NAA-SR-10078) NUCLEAR STARTUP EXPERIMENTS FOR HNPF. M. P. Aronchick (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 26p. Dep.; $2.00(cy), 1(mn) OTS.

The important results of the nuclear startup experiments at the Hallam Nuclear Power Facility are presented and compared with theoretical predictions. The dry critical loading was 30.6 elements, compared with an initial prediction of 23 and an updated prediction of 32. The corresponding wet critical values were 52, 37, and 50 respectively. The experimentally determined excess reactivity for 140 elements at an isothermal temperature of 350°F was 7.5% Δk/k, compared with a predicted 6.9% Δk/k. The experimental sodium worth was 4.1% Δk/k, compared with predictions of 4.8% Δk/k. Total rod worth was measured as 12.5% Δk/k, compared with predictions of 12.7% Δk/k. Other quantities compared and discussed are power coefficients and xenon worth. (auth)

8639 (NAA-SR-10151) TEMPERATURE OSCILLATIONS IN THE SRE. C. L. Peckinpaugh (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT-11-1-GEN-8. 32p. Dep.; $2.00(cy), 1(mn) OTS.

Fuel element temperature oscillations were observed as the power level of the SRE, with the second core loading of thorium–uranium fuel, was increased to 50% of full power. The maximum amplitude of oscillations observed (100°F peak-to-peak) approached allowable limits imposed by stress analysis. Modifications of the fuel elements by spreading apart the rod bundle reduced oscillation amplitudes by a factor of three or more, and thus permitted safe increase of the reactor to full power with a general reduction in the amplitude of oscillations. Extensive experimental work, including measurements with an experimental bowable fuel element, conclusively demonstrated that motion of the entire fuel cluster within the coolant channel was the principal cause of temperature oscillations in the Core II fuel element. Based on this experimental effort the design criteria for a nonoscillating fuel cluster were established. These criteria stated that fuel element designs must: minimize movement and center the element within the coolant channel; provide mixing of sodium in the channel; and match regional power generation to flow rate within the cluster. These design principles were experimentally tested with two special fuel elements and found to be fully adequate, thus providing a proven design basis for Core III fuel design. (auth)

8640 (NAA-SR-Memo-7837) LEAK CHECK OF MODERATOR ELEMENTS IN THE HNPF REACTOR. Jim Mowrey (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 19, 1962. Contract AT-11-1-GEN-8. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An induction probe was used to traverse reactor process channels for leak checking the three moderator elements surrounding a process channel. Fifty-eight process channels were traversed to check the maximum number of moderator elements (129). Twelve elements could not be checked since the process channels around these elements are not accessible through the loading face shield. The induction coil consisted of a primary coil and two secondary coils, with an oscillator connected to the primary coil. The magnitude of the induced voltage in the secondary coils was an indication of the conductivity of the surroundings. The secondary coils were connected to a Sanborn recorder and the signal recorded as the probe traversed each channel. Examination of the recorded traces indicate that there were no leaky moderator elements in the reactor. (auth)

8641 (ORNL-TM-994) ESTIMATION OF INTERIM REPLACEMENT COSTS OF DUAL-PURPOSE NUCLEAR-ELECTRIC SEA WATER CONVERSION STATIONS. S. A. Reed and J. C. Moyers (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Expected useful lifetimes have been obtained or estimated for typical components of dual-purpose nuclear-electric, sea water conversion stations. The component lifetimes were used to prepare tables of sinking fund factors, based on procedures published by the Bureau of Reclamation, for computing the costs of interim replacement of equipment for stations having lifetime expectancies of 30 and 50 years. Employing these sinking fund factors for 4% interest rate, annual interim replacement costs were calculated for a nuclear-electric plant using a 3220 Mwt pressurized water reactor, for a 25,000 Mwt nuclear plant comprised of three pressure tube reactors, and for two multistage-flash evaporator sea water conversion plants which had rated outputs of 165 and 1000 MGD respectively. At 4% interest rate, the annual replacement costs for 30-year-life plants, expressed as percent of initial investment, were estimated to be 0.27 and 0.42% for the 3220 and 25,000 Mwt nuclear-electric plants, respectively, and 0.33 and 0.38% for the 165 and 1000 MGD sea water conversion plants, respectively, exclusive of heat exchange surface. For 50-year-life stations, the annual replacement costs were 0.51% for the 3220 Mwt plant, 0.81% for the 25,000 Mwt plant, and 0.41 and 0.46% respectively for the 165 and 1000 MGD evaporator plants, exclusive of heat exchange surface. The annual replacement cost for the entire evaporator plant, including heat exchange surface, is strongly influenced by the choice of tube and tubesheet material. The annual replacement deposits for the 165 and 1000 MGD conversion plants with copper-base alloys were 2.1 or 2.6% of the initial investment, respectively, for 30-year-life plants, and 2.2 or 2.6%, respectively, for 50-year-life plants. The annual deposit for the 1000 MGD plants would be 0.14 and 0.17% for the 30- and 50-year-life plants, respectively, if titanium were used. (auth)

8642 (TID-21373) EVALUATION OF THE EFFECT OF THE TEMPERATURE DEPENDENT HEAT GENERATION RATE ON THE BURNOUT RESULTS FOR THE UNIFORM AND COSINE HEAT FLUX TEST SECTIONS. US-AEC/AECL Cooperative Program on Heavy Water Moderated Power Reactors. Topical Report No. 3. B. Matzner and F. Castellana (Columbia Univ., New York. Engineering Research Labs.). Oct. 23, 1964. Contract AT(30-3)-187. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The uniform and cosine heat-flux test sections were fabricated from a metal ("A" Nickel) with a strong temperature coefficient of electrical resistivity, which made the axial heat flux distribution a function of heater wall temperature as well as cross sectional area. The magnitude of the deviation from the desired heat flux shapes was calculated. It was found that over 50% of the uniform and 100% of the cosine heat-flux test section burnout data could be used without concern over deviations from the desired heat flux distributions. The remaining uniform test-section data points should also be used without reservation unless future experimental work shows a very strong effect on burnout of axial heat flux distribution. (auth)

8643 (WCAP-3269-28) SAXTON KINETIC EXPERIMENTS. V. Rajagopal (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). June 1964. Contract AT(30-1)-3269. 45p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Several oscillation tests were performed on the Saxton reactor with a view to determine the transfer functions and to study the effects of chemical shim operation on the dynamic behavior of the reactor. The tests consisted of producing pseudo-random, random, or sinusoidal changes in reactivity through an oscillator and measuring the reactor flux and temperature responses by use of correlation techniques. Cross-correlation method with a single series of pseudo-random input permitted analysis of data with small signal-to-noise ratios and over a wide range of frequencies. The transfer functions determined at a power level of 20 Mwt under both borated and non-borated operations show no evidence of any power reversible boron hideout at the test conditions. The transfer functions in both cases had the same shape except for small changes in time constants. By a simplified analysis of the 20 Mwt transfer functions, approximate values of the isothermal fuel and moderator temperature coefficients of reactivity have been determined. Slight increases in fuel time constant and Doppler reactivity effects and a slight decrease in moderator reactivity effects were observed with chemical shim operation. (auth)

8644 A GUIDE TO RELEASE-RATE OF IODINE-131 FROM STACK IN NORMAL OPERATION OF REACTOR. Toshinori Iijima and Ichiro Miyanaga (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 1: 316-21(Nov. 1964).

For estimation of the release rate of ^{131}I, the effect of individual variations by age in the general population and the additional effect of ingestion of foods contaminated in the neighborhood of a reactor are discussed. The limiting release rate from the 55-m stack of the Japan Power Demonstration Reactor is then estimated. The release rate should be determined in consideration of children of ages one and two since in these subjects the positive effect from increase in breathing-rate exceeds the negative effect due to increase in thyroid-mass. The effect from ingestion with green vegetables would become comparable to that from inhalation with air, when the deposition-velocity is 2cm/sec and the intake-rate is about 100 g/day. The limiting release rate from the JPDR is about 4 mC/hr under meteorologically neutral conditions with a mean wind-speed of 2.5 m/sec, which is the most predominant condition at the Tokai site. (auth)

8645 TIME-TEMPERATURE HISTORY IN AN UNDERGROUND CAVITY FOLLOWING RUPTURE OF A PRESSURIZED WATER NUCLEAR REACTOR COOLANT SYSTEM. M. Melice (Bureau d'Etudes Nucleaires, Brussels), R. Mathys, and R. Hersperger. Nucl. Struct. Eng., 1: 14-20(Jan. 1965).

Analysis shows that the pressure in the underground containment cavity of the S.E.N.A. Centrale Nucléaire des Ardennes following a hypothetical rupture of the primary coolant system can be safely controlled by a reasonable program of direct water injection, followed by a quenching overhead spray with cooling and recirculation of the spray water. (auth)

8646 THREE YANKEE REFUELINGS POINT TOWARD MINIMUM DOWNTIME. Karl K. Brown. Nucleonics, 23: No. 1, 64-70(Jan. 1965).

Major Yankee refueling experiences are reported. Reasons for the reduction in refueling time from 4 months to approximately 1 month are discussed. Yankee can refuel in 1 month—working 2 10-hr shifts per day, 6 days per week. With pioneering effort, by modifying, repairing, and replacing equipment, and by using experience to improve techniques, 3 months has been shaved from the time initially required for refueling. Also, total average radiation exposure to personnel during refueling was cut from 3 R per man for the first refueling to 700 mR per man. (P.C.H.)

8647 RESEARCH AND DEVELOPMENT IN ATOMIC ENERGY IN SWEDEN. Gunnar Holte. TVF (Tek. Vetenskaplig Forskning), 35: 252-8(1964). (In Swedish)

Aims and purposes of atomic energy research in Sweden are discussed. Principles of atomic energy production are outlined and the costs of building and running nuclear power plants are calçulated. Data are given about the reactors at Ågesta, Marviken, and Ranstad, as well as about the Atomic Energy Research Center at Studsvik. (auth)

8648 STEAM GENERATING NUCLEAR REACTORS. Albert Green and Donald Wilfred Lawson (to United Kingdom Atomic Energy Authority). British Patent 972,204. Oct. 7, 1964. Filed Mar. 7, 1963.

A steam-generating nuclear reactor has a lattice of 400 coolant-conducting pressure tubes housing nuclear fuel assemblies. Each of the pressure tubes is housed coaxially within a calandria tube containing moderator. The fuel assemblies are clusters of elongated fuel rods in annuli surrounding an imperforate tubular structure disposed along the axis of each pressure tube. Each tubular structure contains a moving column of liquid moderator throttled in its rate of flow. Either light or heavy water may be used for coolant and moderator. (A.G.W.)

8649 NUCLEAR POWER PLANT. Arthur Charles A. Lawrence (to Foster Wheeler Ltd.). German Patent 1,178,955. Oct. 1, 1964. Priority date May 15, 1961, Great Britain.

The plant comprises a reactor vessel, a steam vessel connected to the reactor vessel, and two independent primary circuits with heat exchangers. The heat exchangers of the two primary circuits are arranged in a single, common steam vessel. The steam vessel as well as the reactor vessel are only fixed at a single point. Along their interference the two points practically coincide. (Gmelin Inst.)

Process Heat Reactors

8650 (TID-21288) PROCESS HEAT REACTOR PROGRAM. Quarterly Progress Report, May 1–July 31, 1964. (Bureau of Mines. Morgantown Coal Research Center, W. Va.). 38p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The fluidized-bed gasifier was tested and modified. Operation of the environmental testing apparatus continued using bituminous coal. Work was continued on the new test loop to be used to determine the energy required to circulate gas-solids suspensions. The gas-solids flowmeter developed for investigations with gas-solids suspensions was modified for additional tests in connection with studies of the pneumatic transport of coal. A small closed-cycle gas turbine system to operate at elevated temperatures is being developed. This system will be used to evaluate high-temperature materials for both the turbine and coal-fired gas heater. To evaluate the closed-cycle gas turbine for power generation, analyses of the Brayton cycle were begun. While the assumptions for component efficiencies were optimistic, the results showed that cycle efficiencies of about 50% can be realized with turbine inlet temperatures of 1800 to 2000°F. (N.W.R.)

8651 NUCLEAR POWERED DESALINATION OF SEA WATER FOR SOUTHERN ARIZONA. Roy C. Post and Robert L. Seale (Univ. of Arizona, Tucson). 24p. (CONF-446-47).

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

A discussion concerning selection of the most economical method of providing desalinated water using currently demonstrated technologies is presented. It is concluded that the use of nuclear power to desalinate sea water appears to offer a feasible and potentially economic source of water for municipal areas and for agriculture where extensive transportation is not required. (J.R.D.)

Production Reactors

8652 (HW-81412) THE EFFECT OF DEIONIZED WATER ON REACTOR EFFLUENT ACTIVITIES. PART I. NEW TUBES AND NEW FUEL CHARGES. W. B. Silker and C. W. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 34p. Dep.; $2.00(OTS).

The relationship between reactor effluent radionuclides and tube and fuel jacket surfaces was studied by measuring the building of radioisotopes in the effluent from a new zirconium tube and from a new aluminum tube, both cooled with deionized water. Since nearly all radioisotopes production was associated with the corrosion film on the surface of the aluminum components, no production was ascribed to the surface of the zirconium tube. It was postulated that radioisotopes formed within the aluminum corrosion film entered the coolant by diffusion through the porous film matrix. The concentration buildup could be described mathematically by the equation $C = a(1 - e^{-\lambda t}) + b(1 - e^{-\lambda t})(1 - e^{-\beta t})$, in which the first term describes the radioactive buildup of atoms sorbed on the initial surface, and the second term reflects the added contribution from increasing film porosity. The constants "a" and "b" are the respective steady state coolant concentrations, of radioisotopes from the two surfaces, and include such parameters as number of parent atoms, neutron flux, isotopic cross section, residence time and diffusion coefficient. A value of 0.00987 day^{-1} was determined for β, the porosity growth factor, which corresponded to a reaction half-time of 70 days. This factor was constant for all radioisotopes

measured. Following each fuel recharge, the steady state concentration of ^{24}Na was significantly lower than the level attained during the previous charge. This isotope was formed by fast neutron reaction on aluminum and thus served as an index of effective corrosion film thickness. The reductions in steady state concentration with successive fuel charges were believed to reflect a condition that provided a thinner or less porous film. The fuel element surface was the primary production site for most radioisotopes measured, ^{65}Zn being the only notable exception. (auth)

Propulsion and Space

8653 (GEMP-318) 630A MARITIME NUCLEAR STEAM GENERATOR PROGRESS REPORT NO. 11. (General Electric Co. Advanced Technology Services, Cincinnati). Oct. 30, 1964. Contract AT(40-1)-2847. 85p. Dep.(mn); $3.00(cy), 1(mn) OTS.

A variety of propulsion systems was evaluated; the major effort will be directed toward optimization of a nonreheat power plant with 1515 psia and 1000°F steam conditions. A reactor configuration for the Mark IV design is given. The shield plug, pressure vessel, shielding boiler, containment vessel, fuel materials, safety analysis, and critical experiment are discussed. (D.L.C.)

8654 (NAA-SR-9645) SNAP-8— CONTROL-DRUM ACTUATORS. S. Giles and A. A. Marcus (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 15, 1964. Contract AT-11-1-GEN-8. 30p. Dep.; $2.00(OTS).

Design, development, and test results on electromagnetic actuators for the SNAP-8 control-drum drive system are summarized. The SNAP-8 actuator development is an extension of actuator development for the SNAP-10 system. The environmental and operational requirements of the SNAP-8 system established the need for actuators that would perform reliably with greater torque, longer life, and tolerance to higher levels of irradiation, temperature, shock, and vibration than for SNAP-10. Three models are discussed: two indirect-drive models; and a direct-drive backup design, the 0.5°-step actuator, which has a high torque-to-volume ratio. (auth)

8655 (NAA-SR-Memo-9709) FSM-1 PRE-STARTUP ORBITAL TEST RESULTS. T. J. Boyle and E. M. Ross (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 23, 1964. Contract AT-11-1-GEN-8. 90p. Dep.(mn); $3.00(cy), 2(mn) OTS.

An analysis of the FSM-1 pre-startup orbital test data has been carried out. The objective was to use the data to verify the validity of a low temperature thermal model of the system. The test environment was analyzed and stated in the terms accepted by the system model. It was then possible to simulate the tests on the computer model and compare the computer results with the test data. The agreement obtained was good. The comparisons presented include both time and space variations of system temperatures. Some question as to the validity of the model remains, because of the limitations in the test instrumentation, which made it impossible to exactly determine the test environment. These limitations are discussed both qualitatively and quantitatively. Two key features of the low temperature system thermal behavior were revealed by the test and analysis. First, the thermal response of the system is very slow. Second, the thermal response is relatively insensitive to the flow rate used in the pre-startup period. These are primarily qualitative conclusions; however, a rough quantitative estimate was made of the response time. The indication is that the time required to reach 90% of equilibrium following a change in environmental condition is more than a day. The insensitivity of system response to flow rate was demonstrated by the test data over the range from 9 to 4% of the design flow. Other analyses extend this range down to 2%. (auth)

8656 (NAA-SR-Memo-9824) SNAP-10A PbSnTe T/E PUMP S/N-013 ACCEPTANCE TEST. T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 20, 1964. Contract AT-11-1-GEN-8. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The SNAP-10A PbSnTe T/E pump was acceptance tested in accordance with Specification NAO204-005; and data, as obtained, are submitted with a short summary of the results. The maximum output obtained during the pre-reactor startup test was measured as 0.31 gpm of 100°F NaK at an average pressure of 0.004 psi, with a startup current of 30 amperes. The maximum output obtained during the orbital full flow test was measured as 15.55 gpm of 1010°F NaK at a pressure of 1.045 psi. Based on the results of the tests, T/E pump S/N 013 meets the requirements of the test specification with regards to the "orbital full flow test" but did not meet the "pre-reactor startup" requirements. (auth)

8657 (NAA-SR-Memo-10176) REPORT OF DEVELOPMENTAL TESTING OF SNAP-10A EJECTABLE HEAT SHIELD CONNECTORS. J. M. Townson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 6, 1964. Contract AT-11-1-GEN-8. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The two Reynolds Ejectable Heat Shield Connectors (A2150/A2152-A2151/A2153) used in the Qualification Test Program were modified to reduce required unmating force and were subjected to environmental tests to observe if any degradation occurred. The modifying of each connector included relieving tolerances by milling 0.005 in. from receptacle mating surfaces, strengthening pins by potting receptacles with Stycast 2651 potting compound, and removing brush pins except those to be used in each configuration (+Y and −Y axes). Qualification level shock and vibration tests and thermal-vacuum tests (300°F at 5×10^{-7} torr) were performed. Following each environmental test, an electrical and physical characteristics test was performed. These tests included contact resistance at 1 amp, insulation resistance at 500 v d-c, dielectric strength at 0 to 1000 v rms, unmating force measurements, and physical examination. Special tests were conducted to measure contact resistances and unmating forces at mating gaps of 0.035, 0.040, and 0.045 in. A shock and vibration test was performed with the mating gap set at 0.040 and again at 0.045. Contact resistance was measured before and after each test to observe any changes. (auth)

8658 (NAA-SR-Memo-10248) ANALYSIS OF SNAP-10A REACTOR VESSEL UNDER INTERNAL PRESSURE LOADING. J. D. Sutherland (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 22, 1964. Contract AT-11-1-GEN-8. 40p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The SNAP 10A reactor vessel was analyzed for internal pressure loadings, which occur during ground testing and orbital operation. During ground testing a maximum stress of 10,800 psi, compression, was found to occur at the junction of the lower head with the reactor support ring. During orbital operation, a maximum membrane stress of 1470 psi, compression, was found to occur in the lower head. The maximum membrane stress in the vessel wall during orbital operation is 1390 psi, tension. In all cases, calculated stresses were considerably below allowable values. (auth)

8659 (NAA-SR-Memo-10317) SNAP-10A PbSnTe T/E PUMP S/N-031 ACCEPTANCE TEST. C. M. Quirk and T. M. Funakura (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 19, 1964. Contract AT-11-1-GEN-8. 28p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

The SNAP 10A PbSnTe was acceptance tested. Data are submitted with a summary of the results. The maximum output obtained during the orbital full-flow test was measured as 15.35 gpm of 1010°F NaK at a pressure of 1.068 psi. The maximum output obtained during the pre-reactor-startup test at a NaK temperature of 90°F was measured as 0.36 gpm at a pressure of 0.00810 psi with a startup current of 40 amperes d-c. The pre-reactor-startup test was performed at four test conditions, viz. 100°F NaK, 90°F sink; 90°F NaK, 90°F sink; 80°F NaK, 90°F sink; and 80°F NaK, 70°F sink. (auth)

8660 (PWAC-447) UNMANNED ELECTRIC PROPULSION MISSION CAPABILITIES OF THE SNAP-50/SPUR POWER-PLANT. R. J. d'Arcy and G. C. Sinko (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Oct. 22, 1964. Contract AT(30-1)-2789. 67p. Dep.; $3.00(cy), 2(mn) OTS.

The unmanned electric propulsion space mission studies conducted as part of the SNAP-50/SPUR applications effort are summarized. The performance of electric propulsion vehicles using 300-kw(e) and 1-Mw(e) SNAP-50/SPUR powerplants is determined and compared with solid core nuclear rockets and advanced chemical rockets. The SNAP-50/SPUR powerplant is being developed to provide electric power in space, and electric propulsion is one of the more obvious applications. The over-all objectives or goals of the SNAP-50/SPUR development program include a powerplant with the following characteristics: a net electrical power output of 300-kw(e) to 1-Mw(e); an unshielded powerplant specific weight of 10 to 20 lbs/kw(e); and unattended operation in space for 10,000 hours. The SNAP-50/SPUR powerplant employs a fast spectrum reactor and a Rankine cycle power conversion system to produce electrical power. Lithium is circulated through the reactor circuit by a canned electric motor-driven centrifugal pump. After leaving the reactor at a temperature of about 2000°F, the lithium enters a shell-and-tube boiler where potassium vapor is produced. The potassium vapor is expanded through a multi-stage turbine and condensed in shell-and-tube condenser units. A high-frequency alternator, which produces the electrical power to the ion engines, is directly coupled to the turbine. In addition, power at lower frequencies must be supplied for the pump motors and other auxiliaries of the powerplant. Waste heat is rejected to space from the system by thermal radiation through segmented radiator circuits. NaK is circulated through the condenser units and radiators by electric motor-driven centrifugal pumps. A low temperature auxiliary radiator system is also provided for cooling the pump motors and alternator. The study is based on launch booster capabilities assumed to extend over a range from the normal rated Saturn IB (35,000 pounds in 100-n mile orbit) to the Saturn V (240,000 pounds in 100-n mile orbit). Although this assumption is not wholly realistic, studies have been performed of uprating the Saturn IB launch capability to 50 percent of the Saturn V. This is done through floxing, increasing the first stage tankage length, and attaching solid strap-on rockets. Furthermore, in the period in which this powerplant will be operational, additional launch vehicles may be available. Two types of launch profiles were investigated for the study: launching the spacecraft into a 700-n mile orbit, and launching to earth escape velocity prior to startup of the powerplant. The 700-n mile earth orbit has been tentatively selected, based on the safety considerations of having a sufficiently long lifetime before re-entering the earth's atmosphere to permit appreciable fission product decay. Several specific missions were selected to show the spectrum of missions of varying difficulty within the capabilities of the SNAP-50/SPUR powerplant. (auth)

8661 (SC-RR-64-516) RE-ENTRY FLIGHT DEMONSTRATION NO. 1 (RFD-1): OPTICAL DATA AND FUEL-ELEMENT EXPERIMENT. I. B. White, M. M. Robertson, B. W. Marshall, J. A. Allensworth, and H. L. Ivy (Sandia Corp., Albuquerque, N. Mex.). Oct. 1964. Contract [AT (29-1)-789]. 109p. Dep.; $4.00(cy), 3(mn) OTS.

This report on the RFD-1 optical data and external fuel-element experiment includes a description of the instruments and test components used, a presentation of the data obtained, an explanation of the methods of data reduction employed, and a statement of the conclusions derived. It covers the theory, design, qualification tests, flight-test data, and results of the external fuel-element experiment. Also presented is a theoretical analysis of observed versus predicted ablation times and altitudes for the external fuel elements. In addition, this report presents recommendations for improvements to data acquisition and reduction methods in future, similar flight tests. (auth)

Research and Test Reactors

8662 (EACRP-U-19) LIST OF RESEARCH REACTORS AND CRITICAL FACILITIES. (WESTERN EUROPE AND CANADA). (European Nuclear Energy Agency, Paris). Sept. 1964. 66p. Dep.(mn).

The locations, operators, types, powers, neutron fluxes, operating status and startup dates, and uses of western-European and Canadian research reactors and critical facilities are tabulated by country. A bibliography is included. (T.F.H.)

8663 (HW-83501(Pt.2)) PRTR CONTAINMENT VESSEL PRESSURE TEST EXPERIENCE. PART II. D. R. Koberg (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 10, 1964. Contract AT(45-1)-1350. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The time required to achieve an acceptable leak rate test was considerably more than anticipated. The difficulties encountered with the aqueous containment valves were not foreseen in advance, and the magnitude of the leakage through the many electrical wire runs was greatly underestimated. The large openings into the containment vessel were, in general, more leak tight than was expected. The leak rate for the PRTR containment vessel should stay at the present tested rate in the future, as a result of the extensive permanent sealing performed. Much improvement over the present status will be difficult to achieve because of the method used to seal the wire runs as they pass through the vessel penetration. (auth)

8664 (IDO-16950(Rev.)) ADVANCED TEST REACTOR CRITICAL FACILITY SAFETY ANALYSIS REPORT. E. E. Burdick and J. W. Henscheid, eds. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 1964. Contract AT(10-1)-205. 78p. Dep.; $2.00(OTS).

Reactor physics calculations cannot accurately be made to satisfactorily provide all the data necessary to support test reactor operation. This is especially true in cores with complex geometries like those in the ETR and ATR. A full-scale nuclear mock-up is a valuable adjunct to a large test reactor. It is capable of supplying accurate data on: rod worths and calibrations; excess reactivities, and thus charge lifetimes; neutron flux distributions; gamma generation rates; fuel loading requirements; and effects of the insertion and removal of experiments. Although most of these measurements could be accomplished in the test reactor, the measurements would be much more difficult, would reduce the duty cycle of the reactor, and in some cases would be less accurate. For these reasons, a nuclear mock-up of the Advanced Test Reactor (ATR), presently under construction at the National Reactor Testing Station, also is presently under construction. This facility will be known as the Advanced Test Reactor Critical Facility (ATRC). (auth)

8665 (KFK-231) NUKLEARE MESSUNGEN AM REAKTOR FR2 BEI NENNLEISTUNG. (Nuclear Measurements on the FR-2 Reactor at Nominal Power). H. W. Glauner, M. Diederichs, and W. Eisermann (Kernforschungszentrum, Karlsruhe, Germany). June 1964. 28p. Dep.(mn).

Results of tests carried out on the FR-2 reactor at nominal power are presented in tables and graphs. The temperature effect on the uranium and moderator, fission product poisoning, temperature measurements and determination of the residual power after shutdown, and gamma and neutron dose measurements are discussed. (M.C.G.)

8666 (ORNL-3697(p.165-9)) HPRR OPERATIONS AND SPECIAL PROJECTS. L. W. Gilley, F. F. Haywood, C. R. McAmis, et al. (Oak Ridge National Lab., Tenn.).

The Health Physics Research Reactor was used in a wide assortment of radiobiological, dosimetric, physical, and ecological studies with participating researchers from numerous laboratories and several countries. A feasibility study was completed for the construction of an intense 14-Mev neutron source for the BREN tower; construction began in June 1964. (auth)

8667 (UCRL-7641) LOSS-OF-WATER EXPERIMENT AT THE LIVERMORE POOL TYPE REACTOR. M. Kneze-

vich, R. L. Kathren, O. K. Helferich, and K. R. Kase (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1964. Contract W-7405-eng-48. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The water moderator-coolant covering the core of a pool-type reactor was drained to simulate a credible accident. Radiation levels observed in and around the reactor building indicated that no undue personnel exposures would be sustained unless personnel were situated directly over the reactor core. (auth)

8668 (UCRL-7991) INSTRUMENTATION AND CONTROL FOR SUPER KUKLA PROMPT BURST REACTOR. E. F. Laine (California. Univ., Livermore. Lawrence Radiation Lab.). July 27, 1964. Contract W-7405-eng-48. 18p. Dep.; $1.00(OTS).

Instrumentation and control are described for the Super Kukla prompt burst reactor located at the Nevada Test Site. The test facility, reactor control system, nuclear instrumentation, and instrumentation for the samples undergoing irradiation are described and illustrated. (auth)

8669 A SEMI-EMPIRICAL EQUATION FOR THE THERMAL NEUTRON DISTRIBUTION OF PRR-I. Jose O. Juliano and Cesar L. Pineda (Philippine Atomic Energy Commission, Manila). Philippine J. Sci., 92: 437-40(Dec. 1963).

The neutron-distribution function for the thermal group is presented in such a way that when it is used in the PRR-1 core physics calculations, results comparable in accuracy to those values obtained from digital calculating machines are produced. (J.R.D.)

8670 INVESTIGATIONS USING NUCLEAR REACTOR CARRIED OUT BY LENINGRAD SCIENTISTS. D. M. Kaminker (Ioffe Inst. of Physics and Tech., Leningrad). Vestn. Akad. Nauk SSSR, No. 7, 60-73(July 1964). (In Russian)

The studies carried out with the VVR-M type research reactor in the field of neutron physics are reviewed. These studies included the determination of the properties of excited nuclei created by the capture of thermal neutrons. The discharge, by γ-quantum cascades involving $(n\gamma)$ reactions, yields information concerning the excited levels of the nucleus which cannot be created by reactive decay processes; this applies specifically to the levels of the little-studied odd-odd nuclei. Special instruments were constructed for carrying out experiments based on $(n\gamma)$ reactions: a focusing, Cauchois-type diffraction spectrometer was used to determine the energy and the relative intensity of the γ spectra in the 50 to 1300-kev range with an error between 0.1 and 0.01%. In addition to the determination of the $(n\gamma)$ reactions, the subsequently formed short-lived β-active nuclei of the isomeric states were also studied. A system containing a scintillation spectrometer and a fast chopper or a pendulum-type mechanism was used for the examination of the γ-γ coincidences, measuring both the prompt γ cascades and the lifetimes of the delayed isomeric transitions in the 10^{-9} to 10^{-6} sec range. A dual toroidal, iron-free spectrometer was installed in one of the horizontal beamholes of the reactor for investigating e-e coincidences of the internal conversion electrons; inclusion of a scintillation spectrometer allowed to use the system for the study of e-γ coincidences. The fission phenomena investigated included the determination of the correlation between the emission of fission fragments, γ-quanta and α particles. The angular anisotropy of γ quanta with respect of the direction of the flight of the fragments was measured for the case of the fission of ^{233}U, ^{235}U, and ^{239}Pu nuclei. (TTT)

8671 DESIGN OF UTR-10 FISSION PLATE. Seymour John Raffety. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1964. 75p.

The reactivity coupling between a fission plate and the core of the UTR-10 reactor and of the nuclear hazards associated with such a system were studied theoretically. The proposed fission plate consists of sixteen UTR-10 fuel plates arranged in two overlapping layers. It is located in the shield tank at the end of a 137-cm long graphite duct leading to the core of the reactor. The effective multiplication factor for the fission plate in its graphite-water system is found to be approximately 0.15 indicating that it will be subcritical. The effect of the fission plate on the reactivity of the reactor system is calculated by three methods. The values 1.657×10^{-6} $\Delta k/k$ obtained by perturbation theory and 2.52×10^{-6} $\Delta k/k$ obtained from 2-group diffusion theory agree within a factor of 1.52. The third method of calculation used, which is only an approximate method and not considered to be as accurate as the other two, yields a value of 9×10^{-6} $\Delta k/k$ for the reactivity effect of the fission plate on the reactor system. These values indicate that the addition of the fission plate to the reactor system will present no control problems. The maximum power level of the fission plate assembly is calculated to be 10 watts. This power level is adequate to make it a useful fission neutron source for research work. However, it is found that a fission plate of this power will increase the radiation dose rate at the outer surface of the shield tank by about 4 mrem per hr at the worst point. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 8644.

8672 (HW-81092) PUREX PLANT TEST OF THE CESIUM PHOSPHOTUNGSTATE PROCESS. S. J. Beard and W. C. Schmidt (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 16, 1964. Contract AT(45-1)-1350. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Approximately 98 percent of the cesium in Purex IWW was removed by a single phosphotungstate precipitation. Decontamination factors from the other isotopes could not be determined due to cross-contamination between feed and product streams. Chemical costs for this process were approximately $22.00 per ton of uranium processed to produce the IWW. (auth)

8673 (ORNL-3697(p.3-10)) LIQUID INJECTION INTO DEEP PERMEABLE FORMATIONS. D. G. Jacobs and M. U. Shaikh (Oak Ridge National Lab., Tenn.).

Movement of radionuclides through porous media is due to movement of the transporting water, but is also affected by the ion exchange properties of the medium. Calculations were made for the movement of the solution and radiostrontium through a slab of Berea sandstone and were confirmed by experimental data. The behavior of chloride as a water tracer is complicated by its repulsion by negatively charged soil colloids. The relative exclusion of chloride is especially complicated when clay minerals are present and restricted in their degree of lattice expansion. However, these effects would be decreased as the concentration of electrolyte is increased and would probably be rather insignificant in clean sandstones having low specific surface and high porosity, especially if most of the surfaces were sufficiently separated to permit full development of an electric double layer. Anion exclusion gives a good measure of lattice expansion and collapse of hydrobiotite systems, thereby providing a rather accurate method for measuring the distribution of surface charge density of these interstratified materials. (auth)

8674 (ORNL-3697(p.10-19)) DISPOSAL BY HYDRAULIC FRACTURING. Wallace de Laguna, R. C. Sexton, E. G. Struxness, T. Tamura, and H. O. Weeren (Oak Ridge National Lab., Tenn.).

Water injections were made in the injection well at 986 and 966 ft. These tests confirmed that a fluid loss additive is not a necessary component of the mix to be used in the waste injections. On the last water injection, the sand-erosion technique for slotting failed to cut the casing after 20 min at a jet pressure of 2600 psi. An estimate of the probable operating cost of the shale fracturing plant shows that the cost of the mix and the well life are the significant variables. The well life can be significantly extended by making the batch size large. The Densometer controlled the density of the slurry to within 0.1 lb/gal of the desired density, which is entirely acceptable. Following construction of the surface plant, a series of five injections was made to determine the performance of the plant and the underground behavior of waste slurries of different compositions. In general, the operation of the surface plant was smooth and satisfactory. (auth)

8675 (ORNL-3697(p.19-31)) DISPOSAL IN NATURAL SALT FORMATIONS. W. J. Boegly, Jr., R. L. Bradshaw, F. M. Empson, W. C. McClain, F. L. Parker, W. F. Schaffer, Jr., and Hisashi Kubota (Oak Ridge National Lab., Tenn.).

Renovation of the topside facilities at the Carey Salt Mine, Lyons, Kansas, is essentially complete. Drilling has started on the 19.1-in.-ID waste-charging shaft. Cleanup of the main access tunnels in the mine is in progress. Plastic flow gages are being installed along the access tunnels and near the experimental area to determine the effect of increased temperature on stability of the mine. Design and fabrication of equipment for handling and storing the radioactive fuel assemblies is essentially complete. Laboratory tests of 1000-hr duration on pillar models made from Lyons salt were run at pillar stresses ranging from 4000 to 10,000 psi. From the results of these tests, an empirical equation was derived which correlates well with measured vertical closure rates in the Lyons and Hutchinson mines in openings up to 70 years old. The isolated 2 × 8 × 10 ft heated model room (wall temperature approximately 140°C), after more than a year of heating, has a closure rate ten times higher than it had at ambient temperature. (auth)

8676 (ORNL-3697(p.54-61)) ENGINEERING, ECONOMIC, AND SAFETY EVALUATIONS. R. L. Bradshaw, D. G. Jacobs, J. J. Perona, J. O. Blomeke, and K. E. Cowser (Oak Ridge National Lab., Tenn.).

Costs of permanent storage of calcined radioactive wastes in concrete vaults were five to seven times greater than those for storage in salt, and costs for storage in rooms mined out of granite formations were twice those for storage in salt mines. This economic advantage, plus greater safety, makes salt the preferred choice. Excavation costs were calculated as a function of the amount of salt mined yearly, and $2/ton was found to be a reasonable figure for a relatively large operation. Estimates were made of the movement of ^{90}Sr, ^{106}Ru, and ^{137}Cs in Conasauga shale following a hypothetical release of reactor fuel-reprocessing waste from a tank. Computations were based on hydrologic and exchange characteristics of the local formation. In Conasauga shale, ^{90}Sr would apparently move quite rapidly in an acid waste system, even if the acid would be neutralized by calcite ($CaCO_3$) in the formation. Movement of ^{90}Sr in an alkaline waste solution would be much slower due to the formation of insoluble compounds, in addition to the greater holdup by ion exchange. Ruthenium-106 would be expected to move rapidly in either acid or neutralized waste systems, but it presents little long-term hazard due to its relatively short half-life. The movement of ^{137}Cs would be expected to be slow because of its strong fixation by the ion exchange sites of the illitic fraction of the Conasauga shale. (auth)

8677 DISPOSAL OF RADIOACTIVE WASTES IN THE SEA. Alfredo Spena. Ann. Med. Navale (Rome), 67: 463-84(July-Aug. 1962). (In Italian)

The disposal of highly radioactive industrial wastes is contrasted with that of medium and low activity wastes, which may be treated either by concentration and containment or dilution and dispersion. The U. S. Atomic Energy Commission's standards for alpha, beta, and gamma emitters are reviewed; applications to disposal at sea are noted, both in AEC tests and those of others. The following subjects are considered; the three zones of the oceans: coastal regions, continental shelf, and the open sea, the last of which is divided into superficial and deep strata; the natural radioactivity of the sea; the fate of radioactive wastes immersed in the sea (dispersion, sedimentation, biological assumption by marine bacteria, phytoplankton, zooplankton, benthos, fish); factors affecting the maximum quantity of radioelements disposable in the sea. Maximum permissible doses for various segments of the population are reviewed, and also maximum permissible concentrations relative to the present problem. Disposal of radioactive wastes by nuclear propelled vessels is also discussed. Conclusions are drawn for disposal of small amounts of radioisotopes near the coast, and greater amounts ten miles from the coast at a depth of 1800 m; sampling of algae and phytoplankton every 15 days, fish and crustaceans every month, and sediment every two months; types of controlling bodies; $\frac{1}{25}$ of maximum permissible dose in territorial waters as the upper level, (i.e., 0.02 R/yr), and 0.2 R maximum in 30 yr in the open sea, as safety limits. (BBB)

8678 THE DECONTAMINATION OF RADIOACTIVE WASTE WATER AND POLLUTED AIR FROM RADIOLOGI-

CAL CONTROL AREAS. H. Mende. Gesundh.-Ingr., 84: 90-6(1963).

Handling and disposing of radioactive waste water originating from radiological institutes and clinics are reviewed with particular reference to the methods used for decontamination of radioactive waste discharged into atmosphere and waste water and their safety margins. Details of radiation-proof apparatus, decontamination of isotopes, chemical decontamination, and a specially designed air filter are described. It is emphasized that decontamination should take place before discharge of the wastes. (Public Health Eng. Abstr., 44: No. 10, Oct. 1964.)

8679 THE EXTRACTION OF MOLYBDENUM FROM RADIOACTIVE WASTES. I. L. Jenkins and A. G. Wain (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Appl. Chem. (London), 14: 449-54(Oct. 1964).

GENERAL AND MISCELLANEOUS

8680 (AERE-R-4761) BIBLIOGRAPHY OF UNCLASSIFIED REPORT AND PUBLISHED LITERATURE ON THE TRANSPLUTONIUM ELEMENTS (1957-1964). R. W. Clarke, comp. (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1964. 99p. Dep.; $2.60 (BIS), 13s.0d.(HMSO)

A bibliography of 447 references covering the period late 1957 to autumn 1964 is presented on the chemistry, physics, metallurgy, and nuclear properties of transplutonium elements. The references are arranged according to elements; a general category is also given. A subject index is included. (D.L.C.)

8681 (BDX-613-1) APPLICATION OF PUNCHED CARD TECHNIQUES FOR OPTIMIZING RELIABILITY. Jack H. Swafford and John J. Hoefer (Bendix Corp., Kansas City, Mo.). Feb. 1959. Contract AT(29-1)-613. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The application of punched card data-handling has been shown to provide many services, all of which help in optimizing reliability. The fast feedback of test data and the defect analysis alone justify the use of the system, while lot identification of components, and cataloging of serial numbers are quite necessary in providing an accurate picture of stored-device capabilities. (auth)

8682 (BDX-613-6) ADVANTAGES OF GLASS MICROBALLOONS AS FILLER MATERIAL. F. R. Walterbach (Bendix Corp., Kansas City, Mo). Aug. 10, 1960. Contract AT(29-1)-613. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Epoxy resins are often used with glass hollow microspheres as filler material to encapsulate electronic equipment. An investigation was made to determine the ideal particle size and specific gravity of the microspheres to produce a filled epoxy with optimum thermal shock properties. Specific gravity, thermal conduction, expansion coefficient, thermal shock, tensile modulus, and dielectric constant were the properties measured. (D.L.C.)

8683 (BDX-613-11) EFFECTS OF TEMPERATURE ON FILLED EPOXY ENCAPSULATION MATERIALS. B. A. Davis (Bendix Corp., Kansas City, Mo.). Oct. 14, 1960. Contract AT(29-1)-613. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

As a result of this study, it was learned that voids form in vacuum conditions; that cooling effects differ on the surface of a mold in relation to the surface area of the mold and the volume of material producing heat; and that shielding a mold reduces heat losses and prevents voids, as well as improves the surface finish of filled epoxy castings. (auth)

8684 (BDX-613-12) SURFACE PREPARATION OF PLASTICS FOR ADHESIVE BONDING. Lloyd C. Jackson (Bendix Corp., Kansas City, Mo). Nov. 1960. Contract AT(29-1)-613. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A discussion is presented of some of the factors involved in the preparation of plastics for adhesive bonding: chemical etches, mechanical abrasion, laminates, etc. The mechanical abrasion techniques are considered in more detail. (D.L.C.)

8685 (BDX-613-14) ULTRASONIC SPOT WELD EVALUATION. D. W. Drayer (Bendix Corp., Kansas City, Mo.). [May 1961]. Contract AT(29-1)-613. 10p. Dep. (mn); $1.00(cy), 1(mn) OTS.

The applications of ultrasound are discussed briefly. The use of ultrasound as a detecting and measuring device is considered in more detail, more particularly for the detection of poor bonding in spot welds. The modifications of the technique made to increase its effectiveness, are described. (D.L.C.)

8686 (BDX-613-19) AN ANALOG COMPUTER FOR DEVELOPMENT PROJECT SCHEDULING (thesis). David H. Hax (Kansas. Univ., Lawrence). May 1961. Contract [AT(29-1)-613]. 66p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The purpose of a schedule and a schedule model are described. Three frequently used models are described, each using the same project to illustrate the model. These scheduling illustrations are much smaller in magnitude than is a typical development project schedule in order that various concepts may be illustrated quickly in their entirety. Even so, the relative value of these three models in accomplishing the purposes of a schedule is evident. The network flow diagram of PERT is the clearest representation of the project schedule and best serves the purposes of a schedule model. The computations associated with the PERT model are accomplished on a digital computer. A method of hand computation is described. In using the PERT network flow diagram or any other model, frequent changes are made because of the inability to accurately predict development results or because of attempts to optimize the application of resources. Each time the flow diagram is revised the computations must be repeated. An analog computer makes the effect of changes immediately available and offers a valuable display in gaining approval of the schedule plan or changes in the plan. A direct analog computer is described for finding the PERT critical path in the network flow diagram. The computer is generalized for possible application to other problems. (auth)

8687 (BDX-613-34) TIMESAVING WITH A PARALLEL ANALYZING CHANNEL ATTACHMENT. James S. Carson (Bendix Corp., Kansas City, Mo.). June 1962. Contract AT(29-1)-613. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

For the measurement of the thicknesses of a Au–Ag double-layer coating, a parallel analyzing channel was added to an x-ray spectrographic attachment. The channel includes a holder for holding two crystals and enables the measurement of the Ag and Au spectrographic lines to be carried out without moving the sample. (D.L.C.)

8688 (BDX-613-35) GENERAL TECHNOLOGY OF ADHESIVES. L. C. Jackson (Bendix Corp., Kansas City, Mo.). [1962]. Contract AT(29-1)-613. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

After a brief discussion of the history, industry, and various classifications of adhesives, a survey of adhesive technology is presented. Basic stresses, joints, surface preparation, and forces working for and against adhesion are discussed. Requirements of adhesives are outlined, and the uses of adhesives in various fields are described. (D.L.C.)

8689 (BDX-613-36) AUTOMATIC MEASURING OF TEMPERATURE COEFFICIENTS. IMPROVEMENTS IN AN AUTOMATIC TESTING DEVICE FOR MEASURING TEMPERATURE COEFFICIENTS OF CAPACITORS. Leo A. Schlesselman and Earl M. Sieggen (Bendix Corp., Kansas City, Mo.). Nov. 1962. Contract AT(29-1)-613. 23p. Dep.(mn); $1.00(cy), 1(mn) OTS.

This report describes an automatic tester for measuring temperature coefficients. Test time is reduced 6000 percent (16 hours to 10 minutes), permanent records of characteristics are created, and self-compensating precision is attained. Developments of automatic programing and refined packaging make this device ideal for quickly obtaining accurate temperature coefficient and capacitance drift data from small capacitors. (auth)

8690 (BDX-613-37) THE ANALYSIS OF TIN–INDIUM–ZINC ALLOYS. M. V. Davis (Bendix Corp., Kansas City, Mo.). Dec. 21, 1962. Contract AT(29-1)-613. 4p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A volumetric method is presented for the determination of In, Zn, and Sn in In–Sn–Zn alloys. In the method, the alloy is dissolved, tartrate and fluoride are added, excess EDTA and methylthymol blue indicator are added, and the

excess EDTA is titrated with standard In solution. Cyanide is then added, and the released EDTA (equivalent to the Zn present) is titrated again with In solution. Sn is then determined iodometrically. (D.L.C.)

8691 (BDX-613-42) BONDING FLUOROHALOCARBONS TO COPPER FOR ELECTRICAL APPLICATIONS. Lloyd C. Jackson (Bendix Corp., Kansas City, Mo.). Nov. 1963. Contract [AT(29-1)-613]. 10p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

A process for bonding chlorotrifluoroethylene polymer plastics to copper conductors is given which is based on the utilization of a black oxide coating on the copper. The oxide coating is formed by a caustic chlorite solution [Ebonol "C"]; the effects of time and temperature of the processing in this solution on the adhesion of laminations were investigated. Dynamic peel strength values which were obtained using this method are given. (D.L.C.)

8692 (BDX-613-48) STRUCTURAL STUDIES OF RIGID URETHANE FOAMS. Final Report, September 30, 1963. C. J. Wiegand (Midwest Research Inst., Kansas City, Mo.). For Bendix Corp., Kansas City, Mo. Contract AT(29-1)-613. 19p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Infrared spectroscopy was used for the quantitative estimation of urea, biuret, urethane, and allophanate linkages in rigid polyurethane foams. Absorbance measurements from spectra of quantitative dilutions of foam samples in potassium bromide pellets provided data for calculating the quantities of the four types of linkages present. The foams that were tested contained appreciable quantities of biuret and allophanate linkages and apparently the course of the foam producing reaction differs from that postulated on known properties of the reactants. Appreciable quantities of isocyanates were found in most of the foamed products. (auth)

8693 (BDX-613-53) ELONGATION AS A QUANTITATIVE MEASUREMENT. E. P. Patterson (Bendix Corp., Kansas City, Mo.). Dec. 1963. Contract [AT(29-1)-613]. 68p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Present methods of elongation measurements are limited in their accuracy. A study was made to obtain more accurate elongation measurements. The method employed involved obtaining point elongations by specimen micrometer measurements at equal distances from the fracture face and calculating mean and gage elongations therefrom. Examples of the use of the method for various metals and alloys are given. (D.L.C.)

8694 (BDX-613-57) WHAT CAN THE QUALITY ENGINEER EXPECT FROM MEASURING INSTRUMENTS? R. W. Butler (Bendix Corp., Kansas City, Mo.). Apr. 1964. Contract AT(29-1)-613. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A review is presented of metrology and measurement problems as related to quality control. Electric and electronic testers and mechanical gages are considered. The accuracy, standards, and calibration of the testers and gages are discussed. Costs and education for the metrology profession are considered. (D.L.C.)

8695 (BDX-613-60) THERMOPLASTIC FRONTIER LAWS—GOOD AND BAD GUYS. James C. Daly (Bendix Corp., Kansas City, Mo.). June 1964. Contract [AT(29-1)-613]. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In a brief discussion of the activities at Bendix, the approach taken to select thermoplastics for particular applications is described. Thermoplastic materials with bad and good characteristics are discussed, and some case histories are given. (D.L.C.)

8696 (BDX-613-63) RESISTANCE MEASUREMENTS BY RATIO EMPLOYING VOLTAGE-TO-FREQUENCY CONVERTERS. Engineering Memorandum No. 30. K. H. Brackney (Bendix Corp., Kansas City, Mo.). Aug. 1964. Contract AT(29-1)-613. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A method is presented for measuring resistance in the range of a few milliohms to several hundred ohms by the use of voltage-to-frequency converters. (auth)

8697 (BDX-613-64) THE ANALYSIS OF AN INPUT BUFFER FOR REMOTE CONTROL OF LOGIC CIRCUITS (thesis). Herbert G. Thorpe (New Mexico State Univ., University Park). Dec. 1964. Contract [AT(29-1)-613]. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

In logic circuitry, the use of relays, switches, or contacts for control can give incorrect information, due to contact bounce. An analysis is carried out of a buffer used to isolate a digital circuit from external noise while allowing remote control. The analysis is made by breaking the circuit operation into three parts—delay, switching, and recovery—with a fourth part to describe the effect of noise on the input lines. These four parts describe the limits on the input pulse width and pulse rate for various conditions and give the output pulse that could be expected. Experimental data are used to verify the analysis and give an indication of the possible variations in the circuits due to component changes. The analysis is not a worst-case calculation and does not describe the change of circuit operation due to component variations, but is a method of analysis of an unusual and somewhat unconventional silicon controlled rectifier circuit. (auth)

8698 (BNL-7750) CARBONYL-C^{14}-LABELED DL-KYNURENINE. L. V. Hankes (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A method is given for synthesizing DL-kynurenine labeled with ^{14}C at the carbonyl group. The method begins with 2-nitroiodobenzene and $Cu^{14}CN$, and the product is purified by chromatography and crystallization. (D.L.C.)

8699 (BNL-7780) THE FORMATION OF COLLAGEN HYDROXYLYSINE STUDIED WITH TRITIATED LYSINE. Edwin A. Popenoe, Robert B. Aronson, and Donald D. Van Slyke (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Conversion of lysine into collagen hydroxylysine has been studied in vitro in polyvinyl sponge biopsy tissue obtained from rats, and in vivo in chick embryos. Following incubation of the tissue with DL-lysine labeled in the carboxyl group with ^{14}C and on carbon atoms 4 and 5 with ^{3}H, lysine and hydroxylysine were isolated from hydrolysates of the collagen. In both systems the ratio of ^{3}H to ^{14}C in hydroxylysine was very nearly $^{3}/_{4}$ of the ratio in lysine, indicating that in the conversion, only the one hydrogen atom replaced by a hydroxyl group is lost. At least two mechanisms of hydroxylation are consistent with this observation: a direct attack of oxygen on carbon 5, or a dehydrogenation between carbons 5 and 6 followed by addition of the elements of water. Because of the results of other workers, the latter mechanism seems more likely. (auth)

8700 (CALT-221-5) EXPLANATION OF THE VO_2 DISTORTED RUTILE CRYSTAL STRUCTURE AND PREDICTION OF THE MAGNETIC STRUCTURE. William A. Goddard, III (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Nov. 1964. Contract AT(04-3)-221. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The VO_2 distorted rutile crystal structure is explained as resulting from the same interactions as are responsible for the magnetic order, and the VO_2 magnetic structure is predicted. The predicted magnetic structure is unique and involves a ++−−++−− alternation of spins along the nearest neighbor direction (c axis). No magnetic structure has been reported for VO_2 although the Néel temperature is 340°K. The basic assumption used here is that the Heisenberg Hamiltonian, $H = \Sigma_{ij} J_{ij} S_i \cdot S_j$, parameterizes the interactions responsible for the magnetic order. Three different "exchange integrals" J_1, J_2, and J_3 are used. Of the six stable magnetic structures, there are two for which the rutile crystal structure is unstable; one of these leads uniquely to the VO_2 crystal structure. Stable magnetic structures for which the crystal structure is unstable can result for crystal structures other than that of rutile; thus, this approach may lead to elucidation of the causes of other crystal structures besides that of VO_2. The validity of the theory can be checked by experimentally determining the

magnetic structure of VO_2. If the predicted structure is correct, some strong a posteriori evidence will be placed in favor of the validity of the Heisenberg Hamiltonian. (auth)

8701 (COO-875-27) QUANTUM YIELD STUDIES OF THE PHOTODYNAMIC INACTIVATION OF TRYPSIN. Blaine W. Glad and John D. Spikes (Utah. Univ., Salt Lake City). June 1964. Contract AT(11-1)-875. 113p. Dep. (mn); $4.00(cy), 2(mn) OTS.

Photodynamic action is operationally defined as the chemical alteration of a molecule or the damaging or killing of a cell or multicellular organism by light in the presence of an appropriate sensitizing dye and molecular oxygen. Oxygen is consumed in the process. The quantum yield of the photodynamic inactivation of trypsin was studied using methylene blue, a thiazine dye, a xanthene dye, and flavin mononucleotide as sensitizers. The reaction was studied for each dye with respect to several kinetic variables: stirring rate, dye concentration, trypsin concentration, light intensity, pH, sodium phosphate buffer concentration, sodium chloride concentration (ionic strength), temperature, and various protective agents including sodium iodide, histidine, AET, and egg albumin. The reaction in all cases was carried out in air, and molecular oxygen was used up in the process. In stirred systems the time-course of the photodynamic inactivation of trypsin was first-order within experimental error under all conditions examined. In unstirred systems the results with MeB and eosin Y were the same as in stirred systems. With FMN as sensitizer, however, the rate of inactivation in unstirred systems was very low and the reaction deviated markedly from a first-order process. On the basis of other studies in this laboratory, these latter results could be interpreted as demonstrating a different dependence on oxygen partial pressure for the FMN-sensitized system. The effect of dye concentration on the quantum yield of trypsin photoinactivation was studied. MeB-sensitized systems have a quantum yield maximum of 0.0014 at 12.5 uM, eosin Y-sensitized systems have a quantum yield maximum of 0.0027 at 25 uM, and FMN-sensitized systems have a maximum value of 0.0023 at 150 uM. The data indicate that the three mechanisms of action are probably different. (C.H.)

8702 (COO-1148-90) ELECTROOXIDATION IN PYRIDINE AT THE PYROLYTIC GRAPHITE ELECTRODE. W. Richard Turner and Philip J. Elving (Michigan. Univ., Ann Arbor). Dec. 8, 1964. Contract AT(11-1)-1148. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The potential utility of pyridine as a solvent for the investigation of electrochemical oxidation was evaluated by examining the available potential spans for typical background electrolytes and by voltammographing a number of organic compounds. The pyrolytic graphite electrode was used. The potential range is limited by an oxidation at ca. 1.4 volts vs N.Ag.E. of pyridine or of an impurity in it. The voltammetric behavior of the compounds studied indicates that the solvent-electrode combination examined should be of considerable value for studying electrolytic oxidation. (auth)

8703 (DPST-64-83-10) USAEC–AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, OCTOBER 1964. H. S. Hilborn, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 19, 1964. Contract AT(07-2)-1. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Effect of Rod Spacing on Heat Transfer Burnout. A burnout test was completed in the star test section with heat generation in the surrounding rods. The effluent quality at burnout was increased 10% as compared with that measured with no heat generation in the surrounding rods. Physics Experiments with Fuel Assemblies Simulating Burned-up Fuel. The status of the fabrication of the depleted U–Pu fuel assemblies is described briefly. Hydride Orientation and Mechanical Properties of Thin-Walled Zircaloy Tubing. Hydrogen content and hydride cluster length were determined for fracture tensile specimens. The cluster length was found to have a strong reducing effect on the ductility. (D.L.C.)

8704 (HW-68600-45) PLUTONIUM ABSTRACTS. VOLUME 4, NUMBER 11. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1, 1964. Contract AT(45-1)-1350. 13p. Dep.; $1.00(OTS).

Twenty-seven annotated references are presented on new developments in plutonium technology. The references are arranged into the following subject fields: biology and medicine, chemistry, metallurgy and ceramics, physics, reactor technology, and miscellaneous. (D.L.C.)

8705 (ORNL-TM-1016) TRIP REPORT — TVA FERTILIZER PLANT AT MUSCLE SHOALS, WILSON DAM, ALABAMA. R. E. Blanco, H. W. Godbee, and J. M. Holmes (Oak Ridge National Lab., Tenn.). Dec. 9, 1964. Contract [W-7405-eng-26]. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A visit was made to the TVA Fertilizer Plant at Muscle Shoals, Alabama. The installations for production of nitric acid from ammonia, electrolytic production of phosphorous from phosphate rock, and a blending plant for producing mixed fertilizers were inspected. Brief discussions were held on the subject of new methods for fixation of nitrogen, chemical engineering problems, economics, and the parameters required for formulation of fertilizers from an agronomistic viewpoint. Important conclusions reached included the fact that the use of both nitrate and ammonia are required for the formulation of high efficiency fertilizers, and that food crops vary in their food requirements, i.e., rice requires ammonia (or urea) while wheat requires both ammonia and nitrate. The increased efficiency in the production of nitric acid using modern technology vs that used in the installations dating from 1917 was particularly striking. (auth)

8706 (PAN-273) ZASTOSOWANIA ENERGII JADROWEJ. (Applications of Nuclear Energy). J. Huczkowski, J. Maydell, J. Zakrzewski (Polish Academy of Sciences. Inst. of Nuclear Physics, Krakow); and L. Jurkiewicz (Poland. Academy of Mining and Metallurgy. Inst. of Nuclear Tech., Krakow). 1963. 73p. Dep.(mn).

A review is presented of the applications of nuclear energy in Poland and throughout the world. After a brief coverage of nuclear processes in the universe, such as nuclear energy from stars and cosmic rays, the background is given for discussing nuclear explosions, for both military and peaceful uses, as well as methods of detecting explosions. Reactors are discussed as a source of industrial power, and accelerators as both a research and industrial tool. The review includes the applications of radioactivity in industry and the economic aspects. All the above discussions are introductory in nature and do not cover any of the subjects in depth. A description is given of the activities of many of the specific applied nuclear research and technology groups in Poland, and of the work done in certain geographic regions. These include industrial activities as well. Also, the dissemination of educational and technological information in this area, schooling of nuclear technology workers, equipping radioisotopic laboratories, and finally, some organizational and administrative aspects of the field are discussed. (TTT)

8707 (SC-RR-64-1279) THE ECONOMICS OF QUALITY. David L. Field (Sandia Corp., Albuquerque, N. Mex.). Sept. 1964. Contract AT(29-1)-789. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Some basic economic concepts and principles are reexamined from the point of view of quality management, and a series of theoretical models are developed to demonstrate the application of economic analyses to quality situations. A few widely accepted but fallacious notions concerning quality practices performed in the name of economy are examined. (auth)

8708 (SC-TM-64-977) A TACHOMETER FOR MEASURING RPM USING THE HALL-EFFECT PRINCIPLE. D. R. MacKenzie (Sandia Lab., Albuquerque, N. Mex.). Aug. 1964. Contract AT(29-1)-789. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A tachometer-generator system is described which is small enough to be installed inside a 4-inch diameter wind tunnel model. The model spin rate is sensed by magnetically impulsing a Hall-effect transducer mounted on the nonrotating portion of the spin mechanism. Spin rates from 0 to 500 rpm were measured. (auth)

8709 (SC-TM-64-1281) FORCE TEST OF A 2-CALIBER TANGENT OGIVE SHAPE AT MACH 2.0 (PROGRAM III-100). Roger N. Everett (Sandia Lab., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A 2-caliber tangent ogive nose shape on a particular afterbody was tested in the Sandia 12-inch trisonic wind tunnel to obtain shadowgraphs, drag data, and pitching moment data. One configuration was tested at angles of attack from −6 to +13 degrees. No flow separation was detected. (auth)

8710 (SC-TM-64-1288) WIND TUNNEL FORCE AND DYNAMIC TESTS OF THE RFD-2 RE-ENTRY VEHICLE AT MACH 5.4 AND 7.7 (PROGRAMS VI−13 AND 14). J. K. Cole and R. N. Everett (Sandia Lab., Albuquerque, N. Mex.). Oct. 1964. Contract AT(29-1)-789. 37p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A 0.121 scale model of the RFD-2 re-entry vehicle was tested in the Sandia 18-inch hypersonic wind tunnel to determine three-component force and dynamic stability data at Mach 5.4 and 7.7. Three configurations at two roll angles were tested in the force test. Two configurations at two center-of-rotation positions were tested in the dynamic test. Normal force, axial force, and pitching moment coefficients as well as dynamic and static stability derivatives are presented. The model was statically stable under all test conditions. The results of the dynamic stability test were inconclusive. (auth)

8711 (SC-TM-64-1739) POLYMER MOLECULAR WEIGHT DETERMINATION BY HIGH-TEMPERATURE VAPOR PRESSURE OSMOMETRY. J. P. Burger (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract AT (29-1)-789. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Number average molecular weight measurements of polymers have been successfully made by high temperature vapor pressure osmometry employing high boiling solvents. The process of molecular weight determination is separated into calibration and measurements of unknowns. The calibration was carried out in a closed, thermostatically controlled chamber using a nonaqueous probe. This thermoelectric system is based upon the elevation of temperature caused by condensation of dimethylformamide (D.M.F.) vapor in a solution of recrystallized glyceryl tristearate in repurified D.M.F. The rate at which the D.M.F. condenses into the solution and, consequently, the temperature elevation, are both dependent upon the molar concentration of the solution. This difference in thermistor resistance (ΔR) is measured by means of a d-c resistance bridge. The ΔR values obtained are divided by the molar concentration. These data are then plotted and extrapolated to zero concentration. The intercept is the calibration factor K in units of ohms liters/mole. The determination of molecular weights of unknown materials is carried out in a manner similar to calibration. (auth)

8712 (SCL-DC-64-130) APT NUMERICAL DESCRIPTION STUDY. Final Report. M. M. Gutterman (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Aug. 21, 1964. For Sandia Corp. Livermore Lab., Livermore, Calif. Contract AT(11-1)-578. 176p. Dep.(mn); $5.00 (cy), 3(mn) OTS.

The feasibility of utilizing the APT geometric programming capabilities to define parts and to effect automatic drafting of these parts without the use of motion statements is evaluated. Extensions to the present repertoire of APT three-dimensional geometric definitions, particularly surfaces of revolution are also explored and particular surfaces are recommended for addition to the APT system. Several part definition methods utilizing APT geometry, but not requiring APT motion statements, are evaluated. The basic problems in automatic drafting are presented, the steps essential to transform one particular definition into a list of two-dimensional points depicting a view are discussed, and methods for implementing these procedures using parts of APT Sections I and II are described in detail. Finally, recommendations and estimates for extended effort are presented. (auth)

8713 (TID-4005(Pt.1, 8th Ed.)) SUMMARIES OF THE USAEC BASIC RESEARCH PROGRAMS IN METALLURGY, SOLID STATE PHYSICS AND CERAMICS (FY 1964). (Division of Research, AEC and Division of Technical Information Extension, AEC). 384p. Dep.; $4.00 (OTS).

Indexes prepared by Division of Technical Information Extension.

A detailed summary is presented of the research on materials science supported by the Office of Metallurgy and Materials programs of the Division of Research. The summary covers the fiscal year 1964 and is divided into two parts according to research done in AEC laboratories and elsewhere. (D.L.C.)

8714 (TID-20310) THE EFFECT OF THE PHYSICAL ENVIRONMENT ON EXCITED STATES OF AMINO ACIDS AND PROTEINS. Jayanti Nag-Chaudhuri and Leroy Augenstein (Michigan State Univ., East Lansing). [1963]. Contract AT(11-1)-1155. 27p. Dep.(mn); $2.00 (cy), 1(mn) OTS.

Experiments were conducted in an attempt to investigate whether in specific proteins an emitting aromatic residue is in a situation comparable to that of an isolated aromatic molecule in solution or more typical of the surroundings in an amino acid crystal. Different spectroscopic parameters of the three aromatic amino acids and the enzymes trypsin and ribonuclease (RNase) were studied in aqueous solution, in a mixed organic solvent, and in crystalline powders. The wave length of the fluorescence maximum is scarcely affected by changes in the physical environment; however, the position of the maximum of phosphorescence was red-shifted in the crystals by as much as 500 Å compared to the values obtained in an organic solid matrix. For the amino acids, the ratio of fluorescence to phosphorescence is greater in crystals than in either of the two types of solvents utilized; the reverse is observed for the two proteins studied. In all cases, the decay times observed in the crystalline powders were shorter than those observed in the solid solvent systems. Further, the amino acids exhibited a simple exponential decay of phosphorescence only in the glasses; in powders the decay kinetics are more complex. The decay of phosphorescence from trypsin can be fitted by a simple exponential in both frozen aqueous solution and powders, while RNase decay is complex in both of these situations. The results seem to be in reasonable accord with the conclusions of earlier workers concerning the energy transfer and emission properties of aromatic residues in protein molecules, so long as account is taken of the physical environment surrounding the emitting residues. In particular, it is suggested that the emitting tryptophan residues in trypsin are relatively unaffected by changes in the physical state of our experiments, and in general, the emission appears to be most characteristic of that of the "isolated" tryptophan molecule in a solid solvent. This indicates that the tryptophan residues do not participate in intermolecular interactions between trypsin molecules nor are they subject to strong intramolecular quenching effects—perhaps the three tryptophans are all in the interior of the molecule. Like trypsin, the emission from RNase is less affected by changes in the physical experimental conditions than is observed with the amino acids. The data indicate that the emitting tyrosine residues interact more strongly with neighboring residues within the same RNase molecule than with adjacent, but external molecules. (auth)

8715 (TID-21408) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. XI. PRELIMINARY VASCULAR FLORA OF NEOTOMA. Gareth E. Gilbert and Edward S. Thomas (Ohio State Univ., Columbus

and Ohio. Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 128p. Dep.(mn); $4.00(cy), 3(mn) OTS.

Neotoma is a wooded valley of approximately 100 acres located in Hocking County, Ohio. Data are presented on the vascular flora of a watershed of Neotoma. (C.H.)

8716 (TID-21414) THE ABSORPTION OF SOUND IN METHANE-d_3 (thesis). Thomas Riddell Mullins (Vanderbilt Univ., Nashville. Graduate School). Aug. 1964. 55p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The tube method was used to study the ultrasonic absorption properties of methane-d_3. The apparatus consisted essentially of a movable capacitor speaker and a stationary ribbon microphone inside a sound tube of 1.7 centimeters diameter. The f/p range was covered by varying the pressure. At each pressure, the speaker was moved down the tube and the decrease in amplitude was plotted against the distance. The best straight line was drawn through these points and the slope of this line was taken as the total absorption. The relaxation absorption was obtained by subtracting the effects of classical and tube absorption and was plotted against the logarithm of the corresponding f/p value. This plot resulted in a bell-shaped pattern to which the theoretical relaxation absorption curve was fitted by choosing values of the maximum absorption, μ_{max}, and the f/p value at which the maximum occurs, f'_m. The value of μ_{max} chosen was 0.133 nepers per wavelength, which was in close agreement with the theoretical prediction of 0.132 nepers per wavelength. The experimental value of f'_m was 78 kilocycles per atm, which corresponded to a relaxation time of 2.39 microseconds. The experimental value of f'_m was related to the transition probabilities and the collision efficiency through the assumption of a harmonic oscillator model. The relaxation time of the lowest energy mode was found to be 0.587 microseconds. The transition probability was 1.73×10^6 sec^{-1}, and the collision efficiency was determined to be 1.63×10^{-4}. The average number of collisions per energy transfer was calculated to be 6,140. The investigations of the effect of deuteration of methane on intermolecular energy transfer indicate that, with the exception of an interchange of CH_3D and CH_2D_2, the collision efficiency decreases with deuteration. Proceeding on the assumption that impurities are not a factor, the possibility of a change in the interaction potential of the molecules in CH_3D is suggested based on the results of recent viscosity measurements. (auth)

8717 (Y-OA-21) NEW TECHNIQUES FOR OUT-OF-PLANT PACKAGING AND INTERNAL-HANDLING CONTAINERS. C. R. Riggs (Union Carbide Corp. Nuclear Div. Y-12 Plant, Oak Ridge, Tenn.). Aug. 21, 1964. Contract W-7405-eng-26. 23p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

A new concept in the method of packaging parts for intra and inter-plant shipping at Y-12 has been established. Many of the parts manufactured at Y-12 are machined to close tolerances, are fragile, and are made of very expensive materials; therefore, extreme care and protection are required while being transferred, stored, or shipped. The revised packaging concept, utilizing a plastic envelope of air and foam with a flexible pour-in-place urethane foam in a decorative cardboard box replaces the vermiculite filler and specially designed and fabricated plywood containers previously used. This new method makes it possible to afford better protection to a part from the time it is completed at the machine until it arrives at its destination, and at a reduction in cost. (auth)

8718 WORLD NUCLEAR DIRECTORY. An International Reference Book. 2nd Edition, Revised and Enlarged. London, Harrap Research Publications, 1963. 633p. I. £10. 10s. net.

Information is presented on about 3,000 organizations throughout the world with nuclear interests. Wherever possible, the telephone number, cable address, and information concerning the nuclear activities of each organization are included. (J.R.D.)

8719 NUCLEAR ENERGY RESEARCH IN THE UNITED KINGDOM. (United Kingdom Atomic Energy Authority, London). [1964]. 96p.

This book gives a broad indication of the scope of nuclear research and development in U. K. and of the organizations taking part. The organizations include the Atomic Energy Authority, the Central Electricity Generating Board and consortia, research associations and councils, universities, etc. (D.L.C.)

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This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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Proceedings of conferences and conference papers are included in the Report Number Index.

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226	19-7828	Intern. J. Appl. Radiation Isotopes, 15: 617-25(1964)
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2057	19-7858	Can. J. Phys., 42: 2063-79(1964)
2058	19-8596	See CRRP-1199
2066	19-7846	Dep.; $0.50(AECL)
2079	19-8415	Can. J. Phys., 42: 2286-2331(1964)
2084	19-8416	Can. J. Phys., 42: 2384-94(1964)
2094	19-7792	Can. J. Phys., 42: 2443-72(1964)
2097	19-8414	Can. J. Phys., 42: 2173-9(1964)
2110	19-7783	See GPI-57
AED-C–	**(German)**	
04-14	19-7011	Dep.(mn)
12-07	19-8497	Dep.(mn)
21-02	19-7780	Dep.(mn)
AEEW-M–	**(British)**	
347	19-8390	Dep.; $0.90(BIS), 4s. 6d. (HMSO)
AERE-M–	**(British)**	
1219	19-7266	Dep.(mn)
AERE-R–	**(British)**	
4686	19-7781	Dep.; $0.80(BIS), 4s. (HMSO)
4687	19-7696	Dep.; $1.20(BIS), 6s. (HMSO)
4726	19-8466	Phys. Rev. Letters, 13: 756-60(1964)
4761	19-8680	Dep.; $2.60(BIS), 13s. 0d. (HMSO)
AERE-Trans–	**(British)**	
1011	19-7361	Dep.; $0.60(BIS); 3s. (HMSO)

Report No.	Abstract No.	Availability
AFCRL–	**(Non-AEC)**	
62-878	19-7716	
AFOSR–	**(Misc.)**	
64-1448	19-7541	See RAI-331
AGN–	**(Misc.)**	
8121	19-7674	Dep.(mn); $1.00(cy), 1(mn) OTS
ANL–		
6906	19-6910	Dep.; $4.00(cy), 3(mn) OTS
APDA–	**(Misc.)**	
125	19-8627	
APED–	**(Misc.)**	
4413	19-7862	
4527	19-7267	
4542	19-7847	
4612	19-7873	
4625	19-7675	
ASD-TDR–	**(Non-AEC)**	
7-911(V)	19-7874	$2.60(OTS)
63-753(Pt.II)	19-7848	OTS
ATL-A–		
143	19-7889	Dep.(mn); $1.00(cy), 1(mn) OTS
AWRE-Trans–	**(British)**	
47	19-7912	Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL
BAW–	**(Misc.)**	
1280-20	19-7676	Dep.(mn); $3.00(cy), 2(mn) OTS
3238-5	19-7677	Dep.(mn); $2.00(cy), 1(mn) OTS
BDX–		
613-1	19-8681	Dep.(mn); $1.00(cy), 1(mn) OTS
613-6	19-8682	Dep.(mn); $1.00(cy), 1(mn) OTS
613-7	19-7890	Dep.(mn); $1.00(cy), 1(mn) OTS
613-11	19-8683	Dep.(mn); $1.00(cy), 1(mn) OTS
613-12	19-8684	Dep.(mn); $1.00(cy), 1(mn) OTS
613-14	19-8685	Dep.(mn); $1.00(cy), 1(mn) OTS
613-19	19-8686	Dep.(mn); $3.00(cy), 2(mn) OTS
613-30	19-7762	Dep.(mn); $3.00(cy), 2(mn) OTS
613-34	19-8687	Dep.(mn); $1.00(cy), 1(mn) OTS
613-35	19-8688	Dep.(mn); $1.00(cy), 1(mn) OTS
613-36	19-8689	Dep.(mn); $1.00(cy), 1(mn) OTS
613-37	19-8690	Dep.(mn); $1.00(cy), 1(mn) OTS
613-42	19-8691	Dep.(mn); $1.00(cy), 1(mn) OTS
613-48	19-8692	Dep.(mn); $1.00(cy), 1(mn) OTS
613-53	19-8693	Dep.(mn); $3.00(cy), 2(mn) OTS
613-57	19-8694	Dep.(mn); $1.00(cy), 1(mn) OTS
613-60	19-8695	Dep.(mn); $1.00(cy), 1(mn) OTS
613-63	19-8696	Dep.(mn); $1.00(cy), 1(mn) OTS
613-64	19-8697	Dep.(mn); $3.00(cy), 2(mn) OTS
BLG–	**(Belgian)**	
267	19-7613	Dep.(mn)
BMI–	**(Misc.)**	
1695	19-7536	Dep.; $2.00(cy), 1(mn) OTS
1696	19-7891	Dep.(mn); $2.00(cy), 1(mn) OTS
1706	19-7352	Dep.; $0.50(OTS)
BNL–		
7642	19-7863	Dep.(mn); $1.00(cy), 1(mn) OTS
7645	19-8375	Dep.(mn); $2.00(cy), 1(mn) OTS
7725	19-6946	Dep.(mn); $1.00(cy), 1(mn) OTS
7727	19-7017	Dep.(mn); $1.00(cy), 1(mn) OTS
7745	19-6947	Dep.(mn); $2.00(cy), 1(mn) OTS
7750	19-8698	Dep.(mn); $1.00(cy), 1(mn) OTS
7780	19-8699	Dep.(mn); $1.00(cy), 1(mn) OTS
8167	19-8294	Phys. Rev., 137: B219-20(1965)
8173	19-8457	Phys. Rev., 137: B83-9(1965)
8184	19-8453	Phys. Rev., 137: B58-63(1965)
8250	19-6924	Science, 146: 653-5(1964)
8330	19-6923	Proc. Natl. Acad. Sci. U. S., 52: 1017-24 (1964)

Report No.	Abstract No.	Availability
8392	19-8191	Phys. Rev., 137: B147-54(1965)
8403	19-8450	Phys. Rev., 137: B23-5(1965)
8444	19-7119	Nature, 204: 596-7(1964)
8575	19-7059	Bryologist, 67: 76-87(1964)
8675	19-7018	$3.00(cy), 2(mn) OTS
CALT–		
221-5	19-8700	Dep.(mn); $2.00(cy), 1(mn) OTS
CEA–	(French)	
2444	19-7896	Dep.(mn)
CEA-R–	(French)	
2434	19-7697	Dep.(mn)
2436	19-7268	Dep.(mn)
2445	19-7897	Dep.(mn)
2459	19-8628	Dep.(mn)
2494	19-7849	Dep.(mn)
2526	19-7997	Dep.(mn)
2527	19-8498	Dep.(mn)
2538	19-7269	Dep.(mn)
2586	19-7982	For translation see EURAEC-1095
CEA-tr–	(French)	
X-574	19-7281	Dep.(mn); $1.60(fs), $0.80(mf) JCL
CEND–	(Misc.)	
508	19-7262	Dep.(mn); $2.00(cy), 1(mn) OTS
3107-224	19-7850	Dep.(mn); $2.00(cy), 1(mn) OTS
CERN–	(European Organization for Nuclear Research)	
64-49	19-7782	Dep.(mn)
CLM-P–	(British)	
42	19-8523	J. Nucl. Energy, Pt. C, 6: 617-29(1964)
43	19-8087	Phys. Rev., 137: A361-4(1965)
48	19-8532	Proc. Phys. Soc. (London), 84: 803-5(1964)
CLOR–	(Polish)	
14	19-7281	For translation see CEA-tr-X-574
CNLM–	(Misc.)	
5942	19-7851	Dep.(mn); $2.00(cy), 1(mn) OTS
CONF-364–	(16th Annual Gaseous Electronics Conference, Pittsburgh, Oct. 1963)	
10	19-8247	ORINS. Gmelin, AED-CONF-63-195-14
11	19-8553	ORINS. Gmelin, AED-CONF-63-195-13
CONF-407–	(Electro Chemical Society, Toronto, May 1964)	
7	19-7657	ORINS. Gmelin, AED-CONF-64-060-15
9	19-7995	ORINS. Gmelin, AED-CONF-64-060-18
CONF-416–	(American Physical Society Division of Fluid Dynamics, Cambridge, Mass., Nov. 1963)	
5	19-8037	ORINS. Gmelin, AED-CONF-63-226-23
CONF-425–	(Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963)	
5	19-8634	See EUR-1816.e
CONF-446–	(American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964)	
47	19-8651	ORINS. Gmelin, AED-CONF-64-081-82
48	19-8389	ORINS. Gmelin, AED-CONF-64-081-83
49	19-7996	ORINS. Gmelin, AED-CONF-64-081-84
52	19-8116	ORINS. Gmelin, AED-CONF-64-081-45
54	19-7833	ORINS. Gmelin, AED-CONF-64-081-107
59	19-8608	ORINS. Gmelin, AED-CONF-64-081-56
63	19-8609	ORINS. Gmelin, AED-CONF-64-081-63
65	19-7347	ORINS. Gmelin, AED-CONF-64-081-65
66	19-8610	ORINS. Gmelin, AED-CONF-64-081-66
CONF-452–	(American Physical Society, Washington, D. C., Apr. 1964)	
59	19-8494	ORINS. Gmelin, AED-CONF-64-044-108
62	19-8129	ORINS. Gmelin, AED-CONF-64-044-81
CONF-471–	(American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963)	
46	19-8554	ORINS. Gmelin, AED-CONF-64-268-59
48	19-7673	ORINS. Gmelin, AED-CONF-63-268-54
49	19-8555	ORINS. Gmelin, AED-CONF-64-268-56
50	19-8556	ORINS. Gmelin, AED-CONF-63-268-57
52	19-8500	See IPP/6/9
CONF-481–	(American Physical Society Annual Meeting, New York, Jan. 1964)	
82	19-8493	ORINS. Gmelin, AED-CONF-64-003-113
CONF-506	19-7441	(Symposium on Compounds of Interest in Nuclear Reactor Technology, Boulder, Colo., Aug. 1964)
CONF-512–	(American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964)	
11	19-7972	ORINS. Gmelin, AED-CONF-64-118-15
CONF-524–	(American Institute of Mining, Metallurgical and Petroleum Engineers Annual Meeting, New York, Feb. 1964)	
4	19-7986	J. Appl. Phys., 36: 243-52(1965)
15	19-8366	ORINS. Gmelin, AED-CONF-64-006-25
CONF-543–	(American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964)	
18	19-7516	ORINS. Gmelin, AED-CONF-64-028-28
CONF-555–	(International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964)	
11	19-7760	ORINS. Gmelin, AED-CONF-64-083-12
CONF-571–	(American Chemical Society 148th National Meeting, Chicago, Aug.–Sept. 1964)	
16	19-7517	ORINS. Gmelin, AED-CONF-64-155-10
18	19-7594	ORINS. Gmelin, AED-CONF-64-155-11
19	19-7593	ORINS. Gmelin, AED-CONF-64-155-9
CONF-603–	(Transaction of Meeting, Vacuum Metallurgy, American Vacuum Society, New York, June–July 1964)	
6	19-7884	ORINS. Gmelin, AED-CONF-64-109-9
7	19-7885	ORINS. Gmelin, AED-CONF-64-109-6
CONF-641201–	(American Institute of Chemical Engineers Annual Meeting, Boston, Dec. 6–10, 1964)	
2	19-7650	Dep.(mn); $1.00(cy), 1(mn) OTS
CONF-642–	(Health Physics Society, Cincinnati, June 1964)	
9	19-7761	ORINS. Gmelin, AED-CONF-64-082-36
CONF-649–	(12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964)	
12	19-8495	ORINS. Gmelin, AED-CONF-64-093-10
20	19-7518	ORINS. Gmelin, AED-CONF-64-093-24
21	19-7778	ORINS. Gmelin, AED-CONF-64-093-23
CONF-651–	(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)	
20	19-8369	ORINS. Gmelin, AED-CONF-64-140-14
21	19-8368	ORINS. Gmelin, AED-CONF-64-140-13
23	19-8370	ORINS. Gmelin, AED-CONF-64-140-34
24	19-8117	ORINS. Gmelin, AED-CONF-64-140-33
25	19-8367	ORINS. Gmelin, AED-CONF-64-140-32
26	19-8371	ORINS. Gmelin, AED-CONF-64-140-35
29	19-7974	ORINS. Gmelin, AED-CONF-64-140-31
31	19-7971	ORINS. Gmelin, AED-CONF-64-140-11
32	19-8372	ORINS. Gmelin, AED-CONF-64-140-18
36	19-8373	ORINS. Gmelin, AED-CONF-64-140-17
CONF-657–	(4th Annual Photovoltaic Specialists Conference, Cleveland, June 1964)	
6	19-7826	ORINS. Gmelin, AED-CONF-64-087-5
CONF-715–	(13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 12–14, 1964)	
4	19-7973	ORINS. Gmelin, AED-CONF-64-139-13
CONF-757–	(International Energy Exhibition, Paris, May 21, 1964)	
1	19-7870	ORINS

Report No.	Abstract No.	Availability
CONF-620701	19-6916	**(8th International Cancer Congress, Moscow, July 22–28, 1962)**
CONF-640602	19-8036	**(Proceedings of the International Conference on the Physics and Chemistry of Solid Surfaces, Providence, R. I., June 21–26, 1964)**
CONF-640701		**(International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris, July 6–11, 1964)**
65	19-8136	ORINS
100	19-8135	ORINS
CONF-640702–		**(American Crystallographic Assn. Annual Meeting, Bozeman, Mont., July 26–31, 1964)**
2	19-7892	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-137-12
CONF-640801–		**(4th Electric Propulsion Conference, Philadelphia, Aug. 31–Sept. 2, 1964)**
7	19-8035	ORINS
15	19-8039	ORINS
16	19-8038	ORINS
19	19-8557	ORINS
24	19-7656	ORINS
30	19-7658	ORINS
CONF-641001–		**(Symposium on Radiochemical Methods of Analysis, Salzburg, Austria, Oct. 19–23, 1964)**
3	19-7345	ORINS
5	19-7348	ORINS
8	19-7351	ORINS
15	19-7346	ORINS
17	19-7342	ORINS
29	19-7337	ORINS
31	19-7336	ORINS
33	19-7350	ORINS
36	19-7349	ORINS
37	19-7335	ORINS
38	19-7333	ORINS
40	19-7332	ORINS
43	19-7340	ORINS
46	19-7344	ORINS
48	19-7334	ORINS
49	19-7343	ORINS
51	19-7341	ORINS
52	19-7339	ORINS
53	19-7338	ORINS
COO–		
651-4	19-8629	Dep.(mn); $2.00(cy), 1(mn) OTS
651-5	19-8630	Dep.(mn); $2.00(cy), 1(mn) OTS
790-12	19-6920	Crop Sci., 4: 549-50(1964)
875-27	19-8701	Dep.(mn); $4.00(cy), 2(mn) OTS
1148-90	19-8702	Dep.(mn); $1.00(cy), 1(mn) OTS
1198-193	19-8094	Phys. Rev., 137: A583-602(1965)
1428-6	19-8391	Dep.(mn); $2.00(cy), 1(mn) OTS
CRRP–	**(Canadian)**	
1199	19-8596	Dep.; $3.00(AECL)
CU–	**(Misc.)**	
1932-232	19-8139	See NEVIS-126
DASA–	**(Misc.)**	
1357(App.G) (Vol.IV)	19-7692	$7.60(OTS)
1535	19-8406	See UNC-5090
DCBRL–	**(Canadian)**	
440	19-7065	Can. J. Biochem., 42: 1717-27(1964)
442	19-7744	Can. J. Phys., 42: 2373-83(1964)
DLCS–		
3410122	19-8631	Dep.(mn); $2.00(cy), 1(mn) OTS
3990312	19-8632	Dep.(mn); $1.00(cy), 1(mn) OTS
DMIC–	**(Non-AEC)**	
207	19-7893	
DMIC-Memo–	**(Non-AEC)**	
179	19-7898	
DP–		
896	19-7614	Dep.; $2.00(OTS)
935	19-8633	Dep.; $2.00(OTS)
DPSPU–		
64-30-1	19-7725	Dep.(mn); $1.00(cy), 1(mn) OTS
DPST–		
64-83-10	19-8703	Dep.(mn); $1.00(cy), 1(mn) OTS
DRI–	**(Misc.)**	
2197	19-7894	Dep.(mn); $1.00(cy), 1(mn) OTS
2198	19-7895	Dep.(mn); $1.00(cy), 1(mn) OTS
DUBNA REPORTS		**(Russian)**
See JINR (Russian)		
EACRP-U–		**(European-American Committee on Reactor Physics)**
19	19-8662	Dep.(mn)
EANDC-US–		**(European-American Nuclear Data Committee)**
69L	19-8406	See UNC-5090
EFINS–	**(Misc.)**	
64-18	19-8142	Ann. Phys. (N. Y.), 30: 446-75(1964)
EIR–	**(Swiss)**	
71	19-8597	Dep.(mn)
EUR–		**(European Atomic Energy Community)**
1639.f	19-7726	Dep.(mn)
1816.e	19-8634	Dep.(mn)
1832.f	19-8498	See CEA-R-2527
1883.i	19-7763	Dep.(mn)
1897.e	19-8598	Dep.(mn)
2102.e	19-7764	Dep.(mn)
2108.i	19-8599	Dep.(mn)
2157.e	19-8000	Dep.(mn)
2159.e	19-7270	Dep.(mn)
EURAEC–		
1095	19-7982	Dep.(mn); $4.00(cy), 2(mn) OTS
1112	19-7899	Dep.(mn); $1.00(cy), 1(mn) OTS
1121	19-7852	Dep.(mn); $3.00(cy), 2(mn) OTS
1135	19-7889	See ATL-A-143
1163	19-7678	Dep.(mn); $2.00(cy), 1(mn) OTS
1173	19-7853	Dep.(mn); $2.00(cy), 1(mn) OTS
1178	19-8568	Dep.(mn); $3.00(cy), 2(mn) OTS
1192	19-7900	Dep.(mn); $1.00(cy), 1(mn) OTS
1193	19-7867	See GEAP-4504
1200	19-7679	Dep.(mn); $1.00(cy), 1(mn) OTS
1218	19-7975	Dep.(mn); $2.00(cy), 1(mn) OTS
1225(Pt.1)	19-7864	Dep.(mn); $1.00(cy), 1(mn) OTS
1225(Pt.2)	19-7353	Dep.(mn); $2.00(cy), 1(mn) OTS
1233	19-7262	See CEND-508
1235	19-7680	See GEAP-4733
1236	19-8615	See GEAP-3771-14
1237	19-7865	Dep.(mn); $2.00(cy), 1(mn) OTS
1238	19-7976	Dep.(mn); $2.00(cy), 1(mn) OTS
1240	19-7850	See CEND-3107-224
1247	19-7684	See NYO-3114-4
1255	19-7677	See BAW-3238-5
1261	19-7901	Dep.(mn); $2.00(cy), 1(mn) OTS
1264	19-8617	See GEAP-4729
1267	19-7891	See BMI-1696
GA–	**(Misc.)**	
4617(Pt.1)	19-7902	Dep.(mn); $2.00(cy), 1(mn) OTS
5176	19-8376	Dep.(mn); $3.00(cy), 2(mn) OTS
5325	19-7923	J. Chem. Phys., 42: 357-64(1965)
5636	19-7977	Dep.(mn); $3.00(cy), 2(mn) OTS
GEAP–	**(Misc.)**	
3694	19-7978	Dep.(mn); $3.00(cy), 2(mn) OTS
3771-14	19-8615	Dep.(mn); $3.00(cy), 2(mn) OTS
4437	19-7866	Dep.(mn); $5.00(cy), 3(mn) OTS
4504	19-7867	Dep.(mn); $3.00(cy), 2(mn) OTS

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4725	19-8616	Dep.(mn); $2.00(cy), 1(mn) OTS
4729	19-8617	Dep.(mn); $1.00(cy), 1(mn) OTS
4733	19-7680	Dep.(mn); $2.00(cy), 2(mn) OTS
GEMP–	**(Misc.)**	
318	19-8653	Dep.(mn); $3.00(cy), 1(mn) OTS
GPI–	**(Canadian)**	
57	19-7783	Dep.; $0.50(AECL)
HPR–	**(Norwegian)**	
38	19-8635	Dep.(mn)
HW–		
38311(Rev.)	19-7354	Dep.(mn); $1.00(cy), 1(mn) OTS
68600-45	19-8704	Dep.; $1.00(OTS)
78153	19-8618	Dep.(mn); $1.00(cy), 1(mn) OTS
80505	19-7875	Dep.(mn); $1.00(cy), 1(mn) OTS
81092	19-8672	Dep.(mn); $1.00(cy), 1(mn) OTS
81412	19-8652	Dep.; $2.00(OTS)
83443(Rev.1)	19-8569	Dep.; $2.00(OTS)
83501(Pt.2)	19-8663	Dep.(mn); $1.00(cy), 1(mn) OTS
83550	19-7615	Dep.(mn); $1.00(cy), 1(mn) OTS
83608	19-7690	Dep.; $2.00(OTS)
83784	19-8558	Dep.; $2.00(OTS)
I–	**(Misc.)**	
B2122-1	19-7872	See AD-426539
IA–	**(Non-AEC)**	
790	19-7271	Dep.(mn)
986	19-7596	Dep.(mn)
IAEA–	**(International Atomic Energy Agency)**	
R87-1	19-7272	Dep.(mn)
R87-2	19-7273	Dep.(mn)
IDO–		
14636	19-7274	Dep.; $6.00(cy), 3(mn) OTS
16950(Rev.)	19-8664	Dep.; $2.00(OTS)
17029	19-7765	Dep.; $1.00(cy), 1(mn) OTS
IFA-MR–	**(Rumanian)**	
21	19-7766	Dep.(mn)
23	19-7693	Dep.(mn)
24	19-7767	Dep.(mn)
IITRI–	**(Misc.)**	
578P22-9	19-8574	Dep.; $7.00(cy), 6(mn) OTS
1184-15	19-8001	Dep.(mn); $2.00(cy), 1(mn) OTS
T6042-11	19-8570	Dep.(mn); $2.00(cy), 1(mn) OTS
INS-R–	**(New Zealand)**	
32	19-7698	Dep.(mn)
IPP–	**(German)**	
3/23	19-8499	Dep.(mn)
6/9	19-8500	Dep.(mn)
6/11	19-8501	Dep.(mn)
6/17	19-8502	Dep.(mn)
6/28	19-8503	Dep.(mn)
IS–		
852	19-7625	Electrochem. Technol., 2: 282-5(1964)
866	19-7522	Dep.; $3.00(cy), 2(mn) OTS
874	19-8150	Nuovo Cimento (10), 34: 1152-66(1964)
885	19-7429	J. Phys. Chem. Solids, 25: 1305-16(1964)
922	19-8097	Phys. Rev., 137: A673-?(1965)
925	19-7903	Dep.; $4.00(OTS)
940	19-7836	Dep.; $4.00(OTS)
943	19-8348	Phys. Rev., 137: A550-6(1965)
954	19-8002	Dep.; $2.00(OTS)
986	19-7904	Dep.; $2.00(OTS)
992	19-7355	Dep.; $5.00(cy), 3(mn) OTS
993	19-8392	Dep.; $3.00(OTS)
1023	19-7356	Dep.; $2.00(OTS)
1036	19-7854	Dep.; $1.00(OTS)
1046	19-7768	Dep.; $1.00(OTS)
1052	19-7357	Dep.; $1.00(OTS)
ISS–	**(Italian)**	
64/24	19-8393	Dep.(mn)
64/27	19-8394	Dep.(mn)
64/31	19-8395	Dep.(mn)
64/35	19-8396	Dep.(mn)
JINR–	**(Russian)**	
E-1812	19-8248	Dep.(mn)
E-1820	19-8137	Dep.(mn)
P-1784	19-8249	Dep.(mn)
P-1811	19-8397	Dep.(mn)
P-1815	19-8250	Dep.(mn)
P-1826	19-8251	Dep.(mn)
P-1838	19-8138	Dep.(mn)
P-1840	19-8398	Dep.(mn)
KAPL–		
3070	19-7681	Dep.; $3.00(OTS)
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